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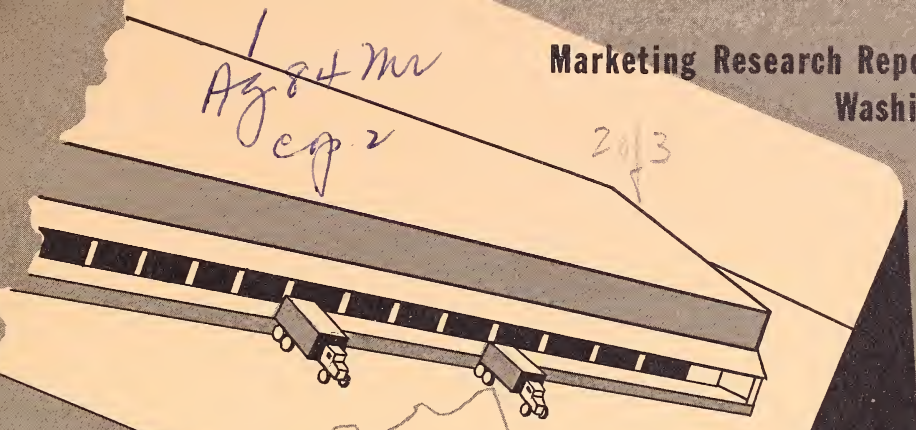

# Materials Handling in Public Refrigerated Warehouses



Marketing Research Division
Agricultural Marketing Service
UNITED STATES DEPARTMENT OF AGRICULTURE

# PREFACE

Large advances in productivity are sometimes achieved by revolutionary techniques; but small increments of improvement, in method and devices, have a cumulative effect that often outweighs the more spectacular innovations.

Since public refrigerated warehouses are the concentration points for millions of tons of commodities each year, many man-hours are expended in handling this huge volume. Improvements in handling techniques resulting in increased labor productivity are of great benefit to producer, warehouseman, distributor, and consumer when adopted throughout the industry.

This report, one of a series on handling food, was developed primarily to guide operators of public refrigerated warehouses in reducing the labor and costs required for various physical handling and warehouse operations. It outlines some of the methods for obtaining increased productivity while minimizing worker fatigue. Although it deals with refrigerated warehouses, the results of the study are applicable to other types of warehousing.

The report is intended as a manual or guide for plant managers and other supervisory workers. Therefore, the methods, types of equipment used, and conditions influencing their use are described in considerable detail.

The cost data include only the cost of productive labor and equipment. Thus, they cannot be used in comparing plant costs for performing handling operations or in budgeting, unless the figures are adjusted to include plant operating costs.

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Credit is due also to the following employees of the Trundle Engineering Company who participated in the research work and gave valuable assistance in assembling, analyzing, and preparing the data used in this report: Daniel L. Harris, Raymond W. Martin, William P. Gmitra, and Joseph R. Zivic.

## SUMMARY

The objectives of the materials-handling research undertaken in public refrigerated warehouses were: (1) To determine the comparative efficiency of various types and combinations of materials-handling equipment for performing the different handling operations with representative types of containers in warehouses of single-story and multistory design; and (2) to determine the best practices in using the materials-handling equipment.

Time studies provided data on the elapsed time required for performing the various operations, and gave the total labor and equipment requirements of the methods and combinations of equipment, in terms of time and cost in materials-handling operations only. The costs of management and the warehouse structure were not included in these evaluations.

The study indicated that the forklift truck can reduce handling costs in multistory warehouses considerably, compared with the platform hand truck type of operation, when unit loads can be placed into storage without sacrificing too much storage space. However, other factors sometimes restrict the use of mechanical handling equipment in multistory warehouses. Some of these are: Structural limitations of the plants, types of commodities handled, and elevator capacity. In the single-story warehouse, forklift trucks are a necessity because the distance between the loading platform and storage point is usually beyond the limits within which a platform hand truck can be profitably employed, and manual labor cannot be used to advantage because of great stacking heights in the storage rooms. The study demonstrated that, on the basis of handling costs only, the single-story warehouse is considerably more efficient, as shown in the tabulation that follows, because elevators, which are essential in multistory warehouses, are not required.

Costs for handling carcass meat in both single-story and multistory warehouses were, without exception, higher than for any of the other commodity types stored. This finding was expected, but when the materials-handling operations were analyzed and the results tabulated, the large differential in costs became even more apparent.

Total costs per ton for each of the 3 materials-handling jobs (moving into, within, and out of storage) for each of the container types and methods observed in 6 selected public refrigerated warehouses were:

| | Labor and equipment cost per ton | | | |
|---|---|---|---|---|
| | 32-pound cans | 32-pound cartons | 101-pound bags | 200-pound carcasses |
| | Dollars | Dollars | Dollars | Dollars |
| **Multistory warehouse** | | | | |
| Shipped by railroad car: | | | | |
| 1. Pallets, hand trucks, and industrial forklift trucks | 1.30 | 1.33 | 1.35 | - |
| 2. Pallets, hand trucks, walkie-type industrial high-lift trucks | 1.34 | 1.35 | 1.39 | - |
| 3. Hand trucks | 1.54 | 1.66 | 1.39 | 3.21 |
| 4. Hand trucks and walkie-type industrial tractors | 1.62 | 1.73 | - | - |
| 5. Hand trucks and gravity roller conveyors | - | 1.74 | - | - |
| Shipped by highway trucks and trailers: | | | | |
| 1. Hand trucks | 1.60 | 1.70 | 1.45 | 3.29 |
| **Single-story warehouse** | | | | |
| Shipped by railroad car: | | | | |
| 1. Pallets, semilive skids, jacks, industrial forklift trucks | 1.04 | 1.07 | .95 | - |
| 2. Pallets and industrial forklift trucks | 1.08 | 1.23 | .88 | 2.18 |
| Shipped by highway trucks and trailers: | | | | |
| 1. Pallets, semilive skids, jacks, and industrial forklift trucks | 1.10 | 1.08 | .92 | 2.39 |

# MATERIALS HANDLING IN PUBLIC REFRIGERATED WAREHOUSES

By Theodore H. Allegri, industrial engineer, and Joseph F. Herrick, Jr., agricultural economist, Transportation and Facilities Branch, Marketing Research Division, Agricultural Marketing Service

## INTRODUCTION

A public refrigerated warehouse is defined as an artificially cooled warehouse, the operators of which are engaged in storing food commodities for others for pay.[1] In addition to the public warehouses, there are other types of artificially refrigerated storage facilities. According to the U. S. Department of Agriculture biennial survey published in December 1954, cold storage capacity was composed of the following types and numbers of warehouses:

| | Number |
|---|---|
| Public general | 666 |
| Private and semiprivate general | 499 |
| Meatpacking plants | 198 |
| Apple houses: | |
| Public | 107 |
| Private and semiprivate | 502 |
| Total | 1,972 |

About 15 of the public warehouses were of single-floor design, and the rest were multistory.

The results of an industry-wide statistical survey of the public refrigerated warehouse industry have been reported by the National Association of Refrigerated Warehouses. That report states that the volume of commodities received for storage during 1950 was 6,974,000 tons, and during 1951 it was 7,498,000 tons. This reflects an increase in 1 year of about 10 percent. Employment in the industry increased by 5 percent, from 21,250 to 22,300 persons, while wages rose from $70,040,000 to $80,034,000, or 14 percent.

All of the vast tonnage received for storage must be unloaded from transportation equipment, transported to storage rooms, and placed in storage position, where it remains in custody of the warehouse operators for periods ranging from a day to many months. When called for by its owner, this tonnage must be removed from storage rooms, transported to shipping docks, and loaded into various types of transportation equipment. In addition, it is estimated that 10 percent of the volume is rewarehoused while in storage. This rewarehousing usually consists of consolidating broken lots to provide space for additional lots.

The total tonnage handled is composed of many containers which must be handled, either separately or combined into unit loads, several times during the process of receiving, storage, and shipment. It is, therefore, important to the industry that this vast materials-handling job be performed efficiently and economically. Relatively greater increases in wages paid over increases in tonnage handled, resulting in higher costs per ton handled, create a problem for the warehouse operators, since about 75 percent of all

[1] Some public refrigerated warehouses store certain chemicals and other products that require artificial cooling.

work done in the warehouses consists of materials handling.[2] Also important is the percentage of occupancy of the warehouse space, which varies as a result of use of different materials-handling methods and equipment.

## Objectives of the Research

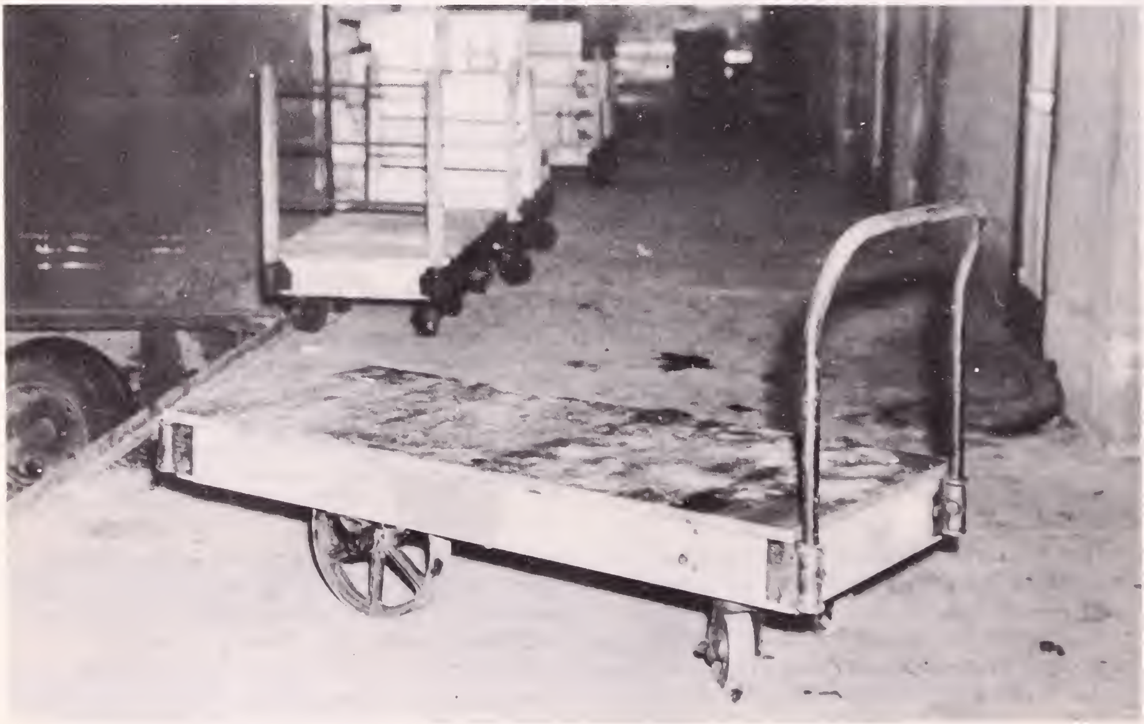
The primary purpose of this research is to suggest changes in current materials-handling methods and equipment, and in the design of facilities, which will reduce the overall cost of materials handling.

Thus, the objectives of this research are: (1) To determine the comparative efficiency of various types and combinations of materials-handling equipment in public refrigerated warehouses; (2) to determine the amount of materials-handling equipment needed, by size, capacity, or design, to do the work most efficiently; (3) to develop and test improved methods of using various types and combinations of materials-handling equipment, and (4) to determine, with respect to materials-handling operations, the comparative efficiency of various layouts and designs for public refrigerated warehouses.

## Principal Types of Materials-Handling Equipment Used

### HAND TRUCKS

One type of equipment used in most of the selected multistory warehouses in this study was the platform or hand truck (fig. 1). In the selected warehouses, these trucks had either 4 or 6 wheels. The 4-wheel trucks had 2 fixed wheels about 12 inches in diameter at one end of the platform, and 2 swivel caster wheels about 6 inches in diameter at the other end. The platforms were about 30 inches wide by 66 inches long, and the trucks weighed about 250 pounds each. A tubular U-shaped handle, fitted in sockets at the swivel-wheel end of the platform, was used to maneuver the trucks. The 6-wheel trucks



Neg. BN-3675

Figure 1.--Four-wheel 250-pound hand truck on truck platform.

[2] "Palletization in the Multistory Warehouse" by James J. Gallery, Distribution Age, June 1948.

had 2 fixed wheels, about 10 inches in diameter, in the center of the platform, and a set of 2 swivel wheels, about 8 inches in diameter, at both ends of the platform. The platforms were about 30 inches wide by 66 inches long and had combination racks and handles at each end of the platforms. These trucks weighed about 330 pounds each.

One of the selected warehouses used hand trucks with steel platforms which weighed about 450 pounds each. Another warehouse used hand trucks which weighed up to 540 pounds each and were 36 inches wide by 72 inches long. The cost comparisons made in this report are based upon use of the 4-wheel, 250-pound trucks. In the discussions which follow, these are referred to as 4-wheel hand trucks, or simply hand trucks.

## ELEVATORS

Elevators were used in all the multistory warehouses studied, to transport loads and personnel between floors (fig. 2). They had variable voltage or rheostat-type controls, and manually operated vertical-sliding cab doors or gates. The elevator equipment in the selected warehouses varied from two 2-ton elevators with 5-by-7-foot platforms, traveling 100 feet a minute, at one plant, to six 8-ton elevators with 11-by-16-foot platforms at another plant. Some of these elevators had doors at both ends of the platforms. The elevators on which the cost comparisons are based were of 6,000-pound capacity, with platforms 7 feet 6 inches wide by 8 feet deep, and a travel rate of 100 feet a minute.

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Figure 2.--Elevator operator reaching to close cab gate.

## BRIDGE PLATES

Bridge plates were used at all the selected warehouses to bridge the gaps between platforms and transportation equipment (fig. 3). Most of these plates were made of 1/4-inch sheet steel, approximately 36 inches wide and up to 60 inches long, with a one-way bevel in the 36-inch edges. Each plate had a row of holes punched lengthwise of the plate, about 4 inches in from each edge. Round head pins were dropped into these holes when the bridge plates were in position in a car door to prevent the plate from moving when the wheels of a truck struck it. Some of these plates had steel angles riveted to their tops lengthwise along the 60-inch edge, to prevent the plate from bending under heavy loads. One of the selected warehouses used bridge plates 48 inches wide by 110 inches long, made of steel side angles and a wood floor, to reduce the grade between the car and the platform. The single-story warehouse used heavily braced steel bridge plates on the car platform. They were too heavy to be handled manually and were moved with a forklift truck. This warehouse used the lighter sheet-steel bridge plates on the truck platform. These were placed in position by 2 handlers. The bridge plate on which the comparative costs are based is one of the simple sheet-steel type, 36 by 60 inches.

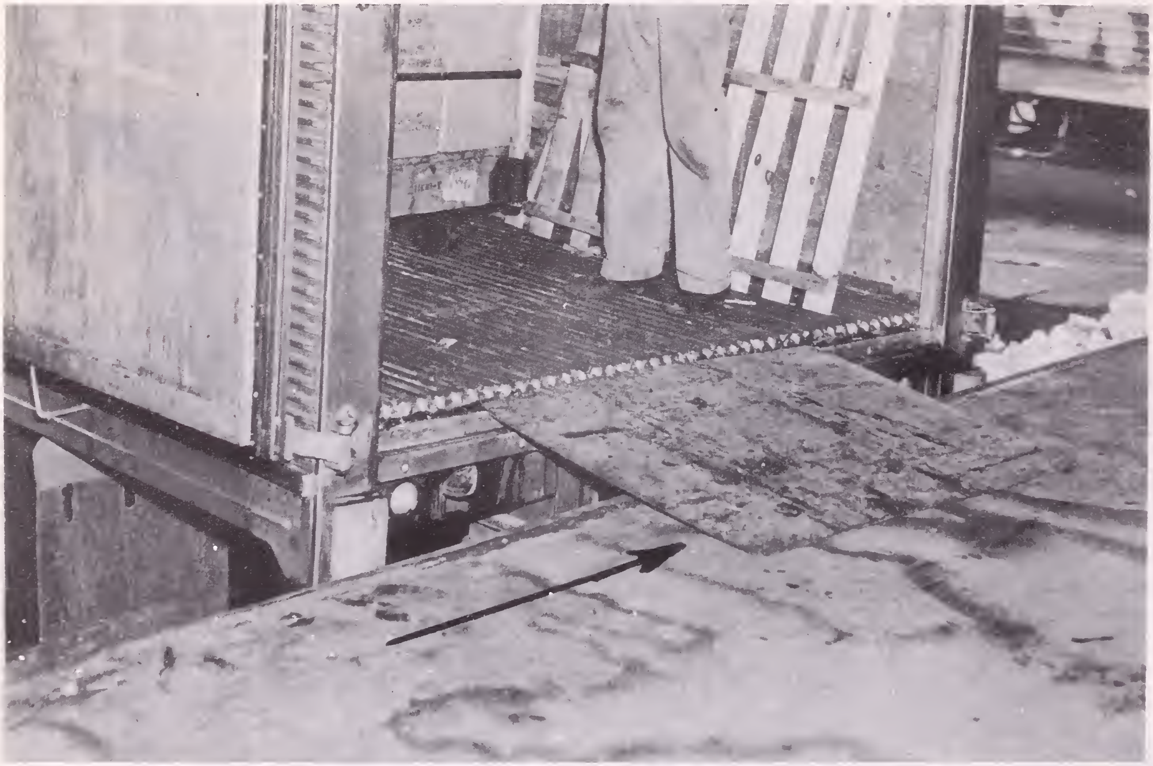

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Figure 3.--Steel bridge plate between platform and truck tail gate.

## GRAVITY ROLLER CONVEYORS

Gravity roller conveyors (fig. 4) had a limited use in the selected warehouses, where they were used during the opening and closing of cars to carry the first and last loads of containers to and from hand trucks placed on the dock. These conveyors consisted of 2 steel angle side bars approximately 10 feet long, equipped with steel rollers 2 inches in diameter by 12 inches long, spaced 3 inches apart on centers. The sections were usually fitted with 2 portable supports to be used when the conveyor was set up for operation. However, in practice, the supports were usually ignored and the conveyor was supported

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Figure 4.--Gravity wheel conveyor used to load the first few cartons on a platform hand truck from a railroad car.

on containers, empty crates, or anything else handy. The wheel conveyor was essentially the same as the roller conveyor, except that, instead of rollers, staggered wheels were used.

## INDUSTRIAL FORKLIFT TRUCKS

Industrial forklift trucks were used in both the single-story and multistory warehouses (fig. 5). In the single-story warehouse, the trucks were used to place the bridge plates in rail cars and highway trucks and to remove them after use, to move stacks of empty pallets to and from the unloading and loading spots, to remove loaded pallets from rail cars and from trucks in unloading operations, to place loaded pallets in the cars and trucks in loading, to transport loaded pallets to and from the storage rooms, to stack loaded pallets in the rooms, and to break the stacks as the loads were required for shipment. In the multistory warehouses, the chief use of the trucks was for stacking and breaking stacks in the storage rooms, where they were used in combination with hand trucks.

Battery-powered forklift trucks were used for storage-room operations in all the selected warehouses. The capacity of these electric trucks varied from 1,500 to 4,000 pounds, with fork lengths and counterbalancing suitable for handling pallet loads 48 inches long. For cost comparisons, industrial forklift trucks of 3,000-pound capacity, capable of handling 48-inch pallet loads, were used.

While gasoline-powered forklift trucks were used on the docks by several of the warehouses included in this study, they were not used in the storage rooms because of


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Figure 5.--Industrial forklift truck removing a loaded pallet from a highway truck door.

danger to the employees from exhaust fumes. The gasoline trucks observed in limited use in this study were predominately of 4000-pound capacity, capable of handling 48-inch pallet loads. No testing of the newly developed catalytic exhaust muffler had been done by this Department at the time of this writing.

## WALKIE-TYPE INDUSTRIAL HIGH-LIFT TRUCKS

Walkie-type industrial high-lift trucks were used to a limited extent in one of the selected warehouses for transportation between elevators and storage rooms and for stacking and breaking stack (fig. 6).


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Figure 6.--Walkie-type industrial high-lift truck.

## WALKIE-TYPE INDUSTRIAL TRACTORS

Industrial tractors were used to tow loaded hand trucks between the elevators and the docks in one of the warehouses in this study. Only one loaded platform hand truck or trailer was towed at a time. Controls of these tractors were located in the handles, and the operators walked ahead of the tractors. The rate of travel was slightly less than the ordinary walking speed of a man, and the extra length of the combined tractor and load made the combination somewhat difficult to maneuver in limited spaces (fig. 7); however, when properly used, this is a valuable piece of equipment.

## INDUSTRIAL TRACTORS

Gasoline-powered industrial tractors (fig. 8) were used in 2 of the selected warehouses. In 1 of the warehouses, the trailing hand trucks were articulated so that they could be steered when the train was backing. In this case, the loaded train was occasionally backed up the loading ramp so that one of the hand trucks was inside the car.

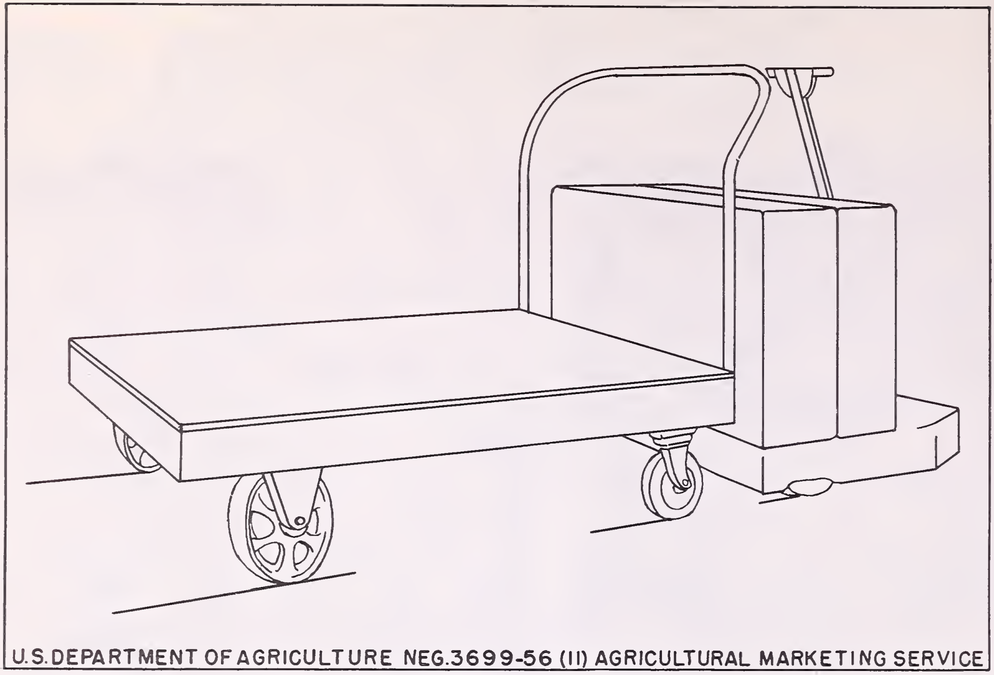


Figure 7.--Walkie-type industrial tractor with trailing hand truck.

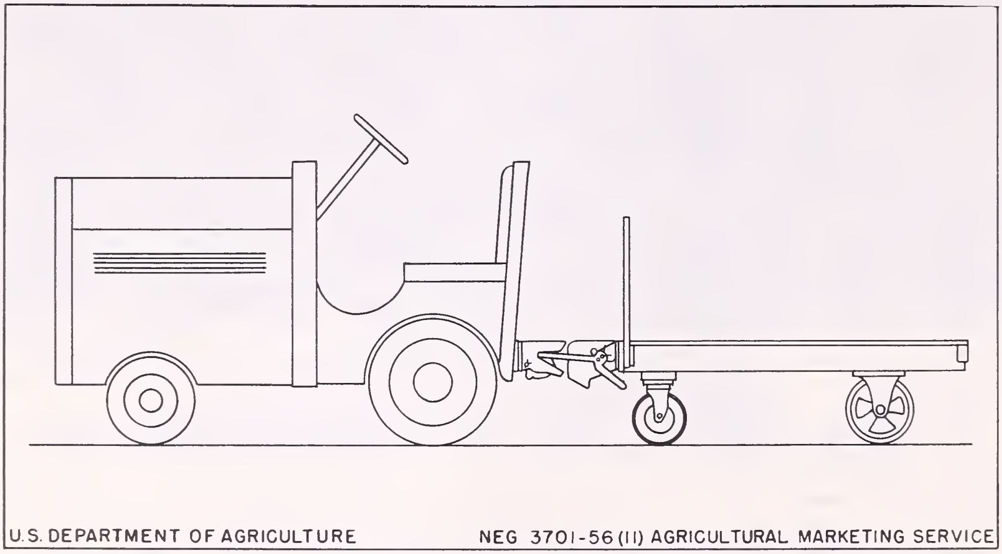


Figure 8.--Gasoline-powered industrial tractor coupled to a trailing hand truck.

## SKIDS AND JACKS

Semilive skids and jacks (fig. 9) were used in several of the selected warehouses. In one warehouse, they were used to transport containers in the same manner as hand trucks. In another, they were used to carry loaded pallets between the car doors and the work face inside the car (the place inside the car where packages are being handled). When unloading a car, an empty pallet was placed on the skid, which was pushed to the work face inside the car. The containers were then handstacked onto the pallet. The skid,

bearing the loaded pallet, was then pulled with the jack to the car door, where the loaded pallet was removed from the semilive skid with an industrial forklift truck.

Neg. BN-3681

Figure 9.--Spotting (placing) a load with a semilive skid and jack.

Tip 9 A

## PALLET DOLLIES

Pallet dollies were used in several of the selected warehouses. They were not observed in use during the survey. It was stated that the semilive skid and jack, described above, serve the same purpose, and the semilive skid can be steered with the jack to place the pallet loads in the car door where they can be removed easily by the forklift truck. The pallet dollies that were observed could move in a straight line only, and were used, in conjunction with pallets, to unload highway trucks and trailers. The two pieces of equipment are considered to be identical in making cost comparisons. There are pallet dollies available that may be turned through 360° of travel and are easily maneuvered (fig. 10).

## PALLETS

Standard-sized pallets (fig. 11) were used in several of the selected warehouses. The sizes observed in use varied from 32 by 40 inches to 48 by 48 inches. Cost comparisons used later in the text are based upon a standard two-way pallet 40 by 48 inches.

## Types of Packages Studied

Public refrigerated warehouses receive packages of many sizes. Packages of varied size, density, and weight observed in the warehouses studied were:

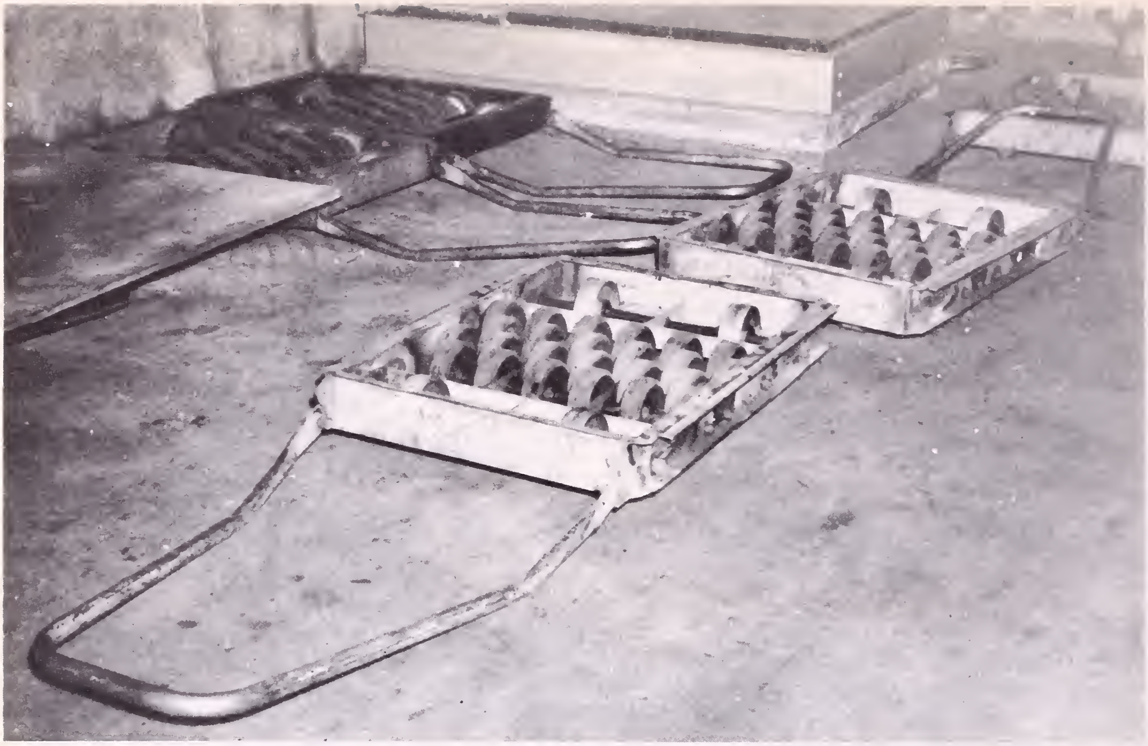

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Figure 10.--Pallet dollies used to pull pallets to or from the work face inside a refrigerated car.


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Figure 11.--A pallet on a pallet dolly (lower right), with a pile of crate-type pallets behind it. Forklift truck at left, ready to pick up loaded pallet.

(1) Noncubical packages, including 32-pound cans measuring 10 inches in diameter by 12-3/8 inches in height;[3] half-bushel and bushel baskets; hexagonal drums of varying sizes; and 752-pound drums measuring 24 inches in diameter by 35-3/4 inches in height;

(2) Cubical rigid packages, including cartons 7 by 7 by 13-1/2 inches, weighing 18 pounds; cartons 12 by 11-1/2 by 8-3/4 inches, weighing 32 pounds; and crates 49-1/2 by 23 inches, weighing 230 pounds;

(3) Nonrigid packages, including half-bushel sacks weighing 50 pounds, and bales 32 by 72 inches, weighing 575 pounds;

(4) Irregular-sized items, such as hams weighing 14 to 18 pounds, 35-pound beef rib cuts; 160-pound veal sides; and 190- to 250-pound beef hindquarters.

In addition, since the densities of the many package types handled by public refrigerated warehouses vary from less than 5 pounds per cubic foot to more than 70 pounds, it was decided that representative package types should be studied. Also, if representative types of packages were studied for each of the major handling methods observed, a comparison of handling costs would be possible. Thus, for the purpose of comparing handling costs, the varied types of packages handled by the warehouses during this study were grouped into four general types: (1) Noncubical packages, such as 32-pound cans, which are approximately 10 inches in diameter and 12-3/8 inches high; (2) cubical rigid packages, including 12-inch by 11-1/2-inch by 8-3/4-inch cartons weighing 32 pounds; (3) nonrigid packages, including half-bushel sacks weighing 50 pounds each and bags weighing 101 pounds; and (4) irregular items, including 35-pound beef rib cuts, 160-pound veal sides, and 200-pound beef hindquarters.

## Description of Public Refrigerated Warehouse Operations

This research was based on a case study approach and embraced operations in 6 public refrigerated warehouses in 6 States. Five of the warehouses were multistory buildings and 1 was a single-story building. These 2 general types of warehouses present wide variations in design and construction of facilities and in materials-handling equipment and methods used. However, the general sequence of operations was the same in both types of structures.

Commodities were received at the warehouses either in refrigerated rail cars, or in refrigerated highway trucks and trailers. Some shipments were received in boxcars, or in uninsulated trucks or trailers, but this was exceptional, since most of the commodities handled would spoil or deteriorate unless they were held at reduced temperatures. Shipments were received in full car lots in most cases, but partial carloads also were received. This was also true of receipts in highway trucks and trailers, although a much larger proportion of truck receipts were in smaller lots. Shipments of as few as 25 containers in a single delivery were received in one of the warehouses.

In all the selected warehouses, it was necessary to unload the containers manually from the transportation equipment. They were handstacked either on hand trucks, on pallets carried on hand trucks, on semilive skids with jacks, or on pallets only, for transportation to the storage rooms.

The labor required to load or unload the rail cars was supplied by the warehouse in all cases. In most cases, the labor to load or unload highway trucks and trailers was supplied either by the owner of the merchandise, by the owner of the truck, or by the truck driver. In some instances, the warehouse supplied one man to help the truck driver.

During the unloading, or soon after receipt of the merchandise on the platform, the shipments were checked by warehouse employees for quantity and condition. Some

[3] As used in this report, the word cubical, as defined in the language of mathematics, means a three-dimensional, rectangular solid. Noncubical, therefore, would mean a non-rectangular solid; however, this solid would not be either a bag, bale, sack, or animal carcass, but would be a barrel or can.

commodities were inspected by representatives of the U. S. Customs Office, U. S. Department of Agriculture, Army Quartermaster Corps, commodity brokers, or others. Most shipments were assigned a lot number by the warehouse. This number was stamped on all or a part of the containers, or on tags attached to the containers or unit loads. The lot number was used to identify the shipment on invoices, orders, inventory cards, and other records.

Containers damaged in transit were repaired by the carrier or by warehouse employees, depending upon the causes of the damage and upon the agreement between the carrier and the warehouse.

If their proportions permitted, the containers were stacked on the hand trucks or pallets in various predetermined patterns so that the load was bound together by the overlapping of the containers in alternate layers. In several of the selected warehouses, the top layer, or tier, of containers was bound with a cord tie horizontically around the outside of the load. This was done chiefly to cases of shell eggs and to 32-pound cans to prevent the merchandise from falling off the truck or pallet. In another warehouse, cardboard separators were placed between the tiers of 32-pound cans. Bulged cartons of processing beef were bound with wire ties into a compact pallet load in another warehouse.[4] These ties were made by a special machine which drew the wire tightly around the containers, twisted it to form a firm loop, and cut it from the supply reel. Binding of loads with ties, as described above, was done to only a few of the loads in the warehouses.

At the single-story warehouse, most shipments were placed on pallets during the unloading of the carrier. The pallet loads were transported with an industrial forklift truck to work spaces, where the inspection and checking operations described above were performed during the short period the loads were in temporary storage. Then the loads were again picked up with a forklift truck, transported to the storage rooms, and stacked in rows and tiers. In this warehouse, the storage room doors were operated either by electric eyes or by manually operated switches, so that it was not necessary for the driver of the forklift truck to dismount to open or close doors.

In the multistory buildings, the containers were handstacked directly on the platforms of the hand trucks, or on pallets carried on the platforms of hand trucks. In both cases, the loads were first transported to the work spaces where they were placed in temporary storage for the inspection, checking, and lot stamping operations. After checking and lot stamping, the loads were pushed into position at the elevators where there was another short period of temporary storage while waiting for the elevator. The loads were pushed onto the elevator platforms by an elevator operator, who rode with the loads to the desired storage floor and pushed the loads off the elevator into the elevator vestibule. The elevator operator also returned empty hand trucks from the storage floors to the loading platform.

When the containers were stacked directly onto the platforms of the hand trucks, the doors of the storage rooms were opened by the handlers, the loads were pushed into the storage rooms, and then the doors were closed. The workers in the freezer rooms, in the selected warehouse, usually worked in groups of two, although several such groups could operate as a storage room crew. The loads were pushed to the desired stacks, and the containers were handstacked in the storage room piles. The unloaded hand trucks were then returned to the elevator vestibule by the handlers, to the loading platform by the elevator operator, and to the platform position for reloading by the checker, lot stamper, or truck pusher. On some occasions, the empty trucks were loaded with outgoing containers before being returned to the dock, but this depended upon conditions in the warehouse at the particular time. The cooler room doors were occasionally allowed to remain open during the stacking operations in some of the selected warehouses during the winter.

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[4] "Bulged carton" is a rigid cubical container packed so that the center part of the container is thicker than the edges.

When the containers were stacked on pallets, they were carried on hand trucks, and pushed with a truck pusher from the elevator vestibules into the storage rooms, and then to the vicinity of the stacking row in which the loads were to be tiered. This operation sometimes was performed by working floor foremen in one of the warehouses. The pallet loads were tiered in the stacks with either a riding- or a walking-type forklift truck. One worker, in addition to the forklift truck operator, usually was employed in the stacking operation to maneuver the hand trucks while the pallet loads were being removed. In the selected warehouses in which this operation was performed, it was necessary to move the empty forklift trucks onto and off the elevators to transport them between floors as they were required, since there was rarely enough tonnage to be handled on a single floor to keep a forklift truck occupied.

Commodities were usually shipped from the warehouses in smaller lots than those in which they were received. The warehouses usually acted as terminal storage points from which the goods were distributed to surrounding areas. As the shipments were removed from the storage rooms, the space required for the broken lot usually remained approximately the same as was required for the original shipment. To make this lost space available for storage of new lots, it was the practice to remove the remaining containers from the place where they were originally stacked to another location where a number of the smaller lots could be combined or stacked in a more compact pile. The space vacated by the removal of the broken lots was thus made available for the storage of larger incoming lots. It is estimated that 10 percent of receipts eventually were so rewarehoused. The movement usually took place within the storage room in which the lot was originally stacked. Very few instances of intraplant movement between rooms or between floors were observed.

In plants in which hand trucks were used, the containers were handstacked from the old locations onto the platforms of the hand trucks. The loaded hand trucks were then pushed to the new locations and the containers were manually stacked into new piles. In warehouses in which pallet loads were handled, the loaded pallets were removed from the old locations by forklift trucks, then transported to the new locations and replaced in stacks by the truck.

The job of removing the containers from storage and loading them into transportation equipment consisted of about the same operations that comprised the cycle of unloading and placing into storage, except that they were performed in the reverse order. The containers were removed from the stacks, either by handstacking directly on hand trucks or on pallets carried on hand trucks, or as pallet loads by a forklift truck. The loads were transported to the loading platforms on hand trucks and elevators, or by forklift truck in the case of a single-story warehouse, and the containers were handstacked on the transportation equipment.

## Some Characteristics of the Selected Warehouses

The five multistory warehouses in the study differed somewhat in their design and construction. The buildings were all at least five stories high. Two of these buildings had cold-storage rooms on every floor; 1 had cold-storage rooms in the basement, on the dock level, and in 3 upper stories; and one 9-story building had cold-storage rooms on the 5 top floors. The five buildings covered a ground area ranging from 27,500 to 80,000 square feet. The total refrigerated capacity of these buildings varied between 9,250 and 22,000 tons.

The internal construction of all of the multistory warehouses was somewhat similar. Each floor was broken up into a series of storage rooms by heavily insulated walls. The rooms were entered through insulated side hinged doors from elevator vestibules, or from corridors leading from the elevator vestibules. The floor space in all of the rooms was broken up into rectangular areas by heavy building columns. Column spacing varied from 17 feet to 23 feet 6 inches on centers. Ceiling heights of the rooms varied from 8 feet 3 inches to 12 feet 6 inches. The doorways varied from 4 feet 6 inches to 6 feet in width and from 6 feet to 6 feet 6 inches in height.

The elevators in the multistory warehouses varied considerably in size and capacity. The smallest platform was 5 feet 6 inches by 7 feet and the largest was 11 feet by 16 feet. The speeds of the elevators varied from 100 feet to 150 feet a minute. Some of the elevators were located approximately in the center of the buildings, while others were in banks near one of the outside walls.

All the warehouses surveyed had railroad platforms separated from the platforms used by highway trucks and trailers. In the multistory warehouses, the car platform dimensions as well as the truck platform dimensions varied considerably. Platform widths of 10 feet or less and lengths of 100 feet and over were not unusual.

Spacing of columns in the single-story warehouse was 50 feet lengthwise of the building and 55 feet across the building. In addition, both the rail and truck platforms were 15 feet wide.

## CURRENT AND ASSUMED WAGE RATES USED IN COMPUTING LABOR COSTS

The six public refrigerated warehouses observed in this study did not use the same job titles for employees, nor was there uniformity in wage rates between plants. This variation in wage rates is attributed to the widely scattered locations of the selected warehouses and to variations in the labor market among communities. Average hourly wage rates are shown in table 1 to illustrate the range of rates observed.

Since there is great variation in wages paid by this industry, it was decided to classify labor used as unskilled, semiskilled, and skilled, and to use average figures for the rates of pay to show cost relationships.

Loaders, hand truckers, freezermen, and coolermen were classified as unskilled labor; forklift truck operators and others using power equipment were classified as semiskilled; and checkers and working foremen were classified as skilled.

Current wage rates for these three classes of labor were assumed to be: (1) Unskilled, \$1.45 an hour; (2) semiskilled, \$1.55 an hour; and (3) skilled, \$1.65 an hour.

Because of current trends in wage rates, cost comparisons based on current wage rates may not adequately reflect the comparative efficiency of various methods and types of equipment during some future period. Therefore, to show cost relationships if wages

TABLE 1.--Average hourly wage rates for selected jobs in 5 selected public refrigerated warehouses, 1952[1]

| Job title[2] | Average hourly wage rate at warehouse: | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Truckers | 1.00 | 1.085 | 1.225 | 1.705 | 1.73 |
| Freezermen | 1.00 | 1.185 | 1.275 | 1.705 | 1.73 |
| Coolermen | 1.00 | 1.105 | 1.225 | 1.705 | 1.73 |
| Elevator operators | 1.00 | 1.225 | 1.225 | 1.705 | 1.73 |
| Machine operators | 1.15 | 1.085 | 1.25 | 1.705 | 1.78 |
| Checkers | 1.15 | | | 1.825 | 1.78 |

[1]Average hourly wage rates were available from five of the six plants studied.
[2]Not uniform in the industry segment observed.

should increase further, an increase of 25 cents an hour has been made in "current" rates for unskilled, semiskilled, and skilled workers. Wage rates under these assumed conditions are $1.70 an hour for unskilled workers, $1.80 an hour for semiskilled workers, and $1.90 an hour for skilled workers. These rates are used in the sections that follow for computing labor costs under assumed conditions.

## COST OF OWNERSHIP AND OPERATION OF MATERIALS-HANDLING EQUIPMENT

The costs incurred for materials-handling equipment are grouped into two categories: (1) Ownership costs, which are considered to be somewhat fixed or relatively stable from year to year; and (2) operational costs, which are variable and increase or decrease in direct relationship with the hours of use of the equipment.

### Cost of Ownership

Ownership costs include the replacement cost of the equipment, depreciation, interest, insurance, and taxes. The replacement costs of the equipment were obtained from reputable manufacturers. Because of the scattered locations of the selected warehouses and of the warehouses of the industry in general, freight charges for delivery of equipment are not included in the cost. Depreciation is figured on the straight-line basis, using the period of useful life as given in Bulletin "F", United States Internal Revenue Service. Following are the estimates of useful life used in calculations of depreciation: (1) Elevator equipment, 20 years; (2) electric forklift trucks, battery chargers, hand trucks, semilive skids and jacks, pallet dollies, gravity roller conveyors, 10 years; (3) electric storage batteries for forklift trucks, 6.3 years; (4) gasoline tow trucks and bridge plates, 5 years; (5) pallets, 3 years.[5] Interest on investment was taken as 2-1/2 percent of the replacement cost (or 5 percent of the average annual cost). Taxes and insurance were grouped and included as 4 percent of the replacement cost. The estimated hours of use per year for the major pieces of equipment is 2,000 hours. This is based on 6-1/2 hours daily use of the equipment for 308 days a year. Pallets are estimated to have a yearly usage of 10 hours. This is based upon 15 round trips a year at approximately 0.67 hour round trip.

### Cost of Operation

Cost of operation includes the cost of maintenance of equipment and, if necessary, the cost of fuel or power. Maintenance costs include costs of labor, parts for maintenance, repair, overhaul, inspection, and servicing, such as lubrication. The lubrication of all types of equipment used in the freezer rooms is especially important because of the effects of low temperatures upon the lubricants. Passage of the transportation equipment from the low temperature within the storage rooms into the relatively high temperature of platforms and elevator vestibules causes considerable trouble due to condensation of moisture in the equipment. Annual maintenance costs are computed at the following percentages of the replacement costs: Elevators, 1 percent; electric trucks, 1-1/2 percent; gas tractors, hand trucks, semilive skids, jacks, roller conveyors, pallet dollies, and pallets, 10 percent. For gasoline-powered vehicles, the gas and oil consumption figures are based upon the manufacturer's estimates. Gasoline cost is figured at 23 cents a gallon and oil at 40 cents a quart. Power cost for battery-powered equipment is considered to be the cost for charging the batteries. Discharge rate per hour for the batteries is considered to be 10 percent of the capacity of the battery and the efficiency of charging the battery is considered to be 50 percent.

### Summary of Costs of Ownership and Operation

The costs of ownership and operation of various types of materials-handling equipment summarized in table 2 reflect the manufacturers' quoted prices for the different capacities of equipment f. o. b. factory.

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[5] Pallet life was estimated at 3 years by a consensus of warehousemen's experience in the selected warehouses.

TABLE 2.--Estimated costs of ownership and operation of specified types of materials-handling equipment used in selected public refrigerated warehouses, 1952[1]

| Type of equipment | Amount of equipment | Initial cost | Assumed annual use | Cost per year | | Total ownership and operating cost | |
|---|---|---|---|---|---|---|---|
| | | | | Ownership | Operation | Per year | Per hour of use |
| | *Unit* | *Dollars* | *Hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Industrial forklift truck (4,000-pound capacity, electric) and battery charger | 1 | 8,153.30 | 2,000 | 1,442.39 | 190.70 | 1,633.09 | 0.82 |
| Industrial forklift truck (3,000-pound capacity, electric) and battery charger | 1 | 7,240.41 | 2,000 | 1,282.89 | 166.80 | 1,449.69 | .72 |
| Industrial forklift truck (2,000-pound capacity, electric) and battery charger | 1 | 5,985.50 | 2,000 | 1,056.17 | 136.18 | 1,192.35 | .60 |
| Industrial high-lift truck, walkie-type (2,000-pound capacity, electric) and battery charger | 1 | 3,386.60 | 2,000 | 587.15 | 71.64 | 658.79 | .33 |
| Industrial straddle forklift truck, walkie-type (3,000-pound capacity, electric) and battery charger | 1 | 3,386.60 | 2,000 | 587.15 | 71.64 | 658.79 | .33 |
| Industrial tractor, walkie-type (200- to 700-pound draw bar pull, electric) and battery charger | 1 | 1,494.70 | 2,000 | 267.34 | 36.34 | 303.68 | .15 |
| Industrial straddle forklift truck (3,000-pound capacity, electric) and battery charger | 1 | 4,282.90 | 2,000 | 733.34 | 84.40 | 817.74 | .41 |
| Industrial tractor (2,000-pound draw bar pull, gasoline) | 1 | 2,166.00 | 2,000 | 573.99 | 404.60 | 978.59 | .49 |
| 4-wheel hand truck (2,500- to 3,500-pound capacity, steel wheels, platform size 30 by 66 inches) | 1 | 47.92 | 2,000 | 7.91 | 4.79 | 12.70 | .006 |
| 6-wheel hand truck (2,000- to 3,000-pound capacity, steel wheels, platform size 30 by 66 inches) | 1 | 55.50 | 2,000 | 9.16 | 5.55 | 14.71 | .007 |
| Semilive skid (2,500-pound capacity, iron wheels, platform size 36 by 60 inches) | 1 | 37.68 | 2,000 | 6.21 | 3.76 | 9.97 | .005 |
| Jack lift for semilive skid (3,000-pound capacity, iron wheels) | 1 | 47.12 | 2,000 | 7.77 | 4.71 | 12.48 | .006 |
| Gravity roller conveyor (12 inches wide by 10 feet long with 2 adjustable supports) | 1 | 60.67 | 2,000 | 10.02 | 6.07 | 16.09 | .008 |
| Pallet dollie (3,150-pound capacity, size 36 by 36 inches) | 1 | 77.70 | 2,000 | 12.81 | 7.77 | 20.58 | .010 |
| Pallets (36 by 48 inches, 4-way) | 100 | 280.00 | 10 | 111.53 | 28.00 | 139.53 | 13.95 |
| Pallets (40 by 40 inches, 2-way) | 100 | 273.00 | 10 | 108.74 | 27.30 | 136.04 | 13.60 |
| Pallets (40 by 48 inches, 2-way) | 100 | 296.00 | 10 | 117.84 | 29.60 | 147.44 | 14.74 |
| Pallets (40 by 48 inches, 4-way) | 100 | 322.00 | 10 | 128.26 | 32.20 | 160.46 | 16.04 |
| Elevator (3-ton capacity, platform size 7 feet 6 inches by 8 feet, 9 floors) | 1 | 24,300.00 | 2,000 | 2,794.50 | 275.00 | 3,069.50 | 1.53 |
| Elevator (2 1/2-ton capacity, platform size 7 feet 6 inches by 12 feet, 7 floors) | 1 | 20,025.00 | 2,000 | 2,302.88 | 232.25 | 2,535.13 | 1.27 |
| Elevator (2 1/2-ton capacity, platform size 8 by 11 feet, 5 floors) | 1 | 15,575.00 | 2,000 | 1,791.13 | 187.75 | 1,978.88 | .99 |
| Elevator (1 1/2-ton capacity, platform size 8 by 8 feet, 5 floors) | 1 | 14,375.00 | 2,000 | 1,653.13 | 175.75 | 1,828.88 | .91 |
| Bridge Plate (steel, 36 inches wide by 60 inches long) | 1 | 104.00 | 2,000 | 27.56 | -- | 27.56 | .014 |

[1] See Table 86 in appendix for data used in preparing this table.

To obtain the hourly costs, the annual hours of use for each type of equipment were estimated, using as a basis a consensus compiled from the experience of warehouse operators taking part in this research study. The assumed hours of use were checked against the volume of merchandise that could be handled physically in a given period, to ascertain whether the estimates were within reasonable limits. Any one plant might use its equipment more or less than the assumed hours, depending on such factors as seasonality of operations or special product lines handled, and each plant should adjust its own costs accordingly. In most plants, the annual hours of use probably follow rather closely the figures used as a basis for these costs.

## HOW COSTS FOR PERFORMING HANDLING OPERATIONS CAN BE COMPARED

In this study, total labor and equipment costs for performing various operations or groups of operations with different types of equipment were computed. Obviously, these costs do not reflect the value of any loss in quality that may result from rough and ex-

cessive handling, or loss in storage life that may result from failure to move merchandise into storage promptly. Improved handling methods and equipment usually reduce the number of times packages are individually handled.

Although comparisons of the amount of bruises and other injuries caused by various methods and types of equipment are desirable, losses in quality would be difficult to evaluate in economic terms. Therefore, cost comparisons were limited to the direct costs of labor and equipment.

## Cycles of Handling Operations

The major materials-handling operations in a public refrigerated warehouse may be grouped as follows:

1. Unloading from railroad cars and placing into storage.

2. Unloading from highway trucks and placing into storage.

3. Intraplant handling.

4. Moving out of storage and loading into railroad cars.

5. Moving out of storage and loading into highway trucks.

These five groups or cycles of commodity handling will be discussed in the sections that follow.

Time study methods were used to obtain objective measures of the relative efficiency of the various handling methods and combinations of equipment surveyed.

Time studies of the operations, performed while using various methods and types of equipment in the selected plants, provided data on the elapsed time required for performing the different operations and the total labor and equipment requirements of the various methods and combinations of equipment. Data on labor and equipment requirements obtained through the studies, wage rates based on averages of the rates paid in the selected locations, and estimates of present equipment costs based on assumed replacement costs and annual hours of use were used to compute total labor and equipment costs for performing the various cycles of operations in multistory and in single-story warehouses. However, the costs of management and facilities were not included in the cost comparisons in this study, and the data presented should not therefore be assumed to be an indication of total costs in an accounting sense.

In analyzing handling operations for comparative purposes, a number of standard conditions were assumed to be typical of the industry. These standard conditions included transportation distances for materials-handling equipment. Standard distances from transportation equipment to elevators, and from elevator vestibules to stacking points in storage rooms were assigned. Elevator travel, capacity, and speed were identical for operations using different equipment.

## Definitions of Terms

The tables in sections that follow show the amount of productive labor required by workers to perform a particular task, operation, or group of operations. Productive labor is taken from the tables of comparative data shown in the appendix. Productive labor is adjusted for differences in rate at which men work, and contains unavoidable delays--delays that are inherent in the method when using a certain type of equipment or crew size under variable conditions. Productive labor is the amount of work time necessary to complete an operation or cycle of operations.

In certain materials-handling operations, the capacity of the worker is affected by the strenuousness of the activity, so that either the worker finds it necessary to pause to rest or his working pace slows down as the working day progresses. To adjust for this factor, an allowance has been made for fatigue. This allowance has been arrived at through experience and observations. Fatigue allowance is the estimated time allowed in relation to the amount of exertion required in doing a job.

Another allowance included in some of the tables is for crew interference, particularly in hand-trucking operations. Interference occurs when one member of a crew halts the work of or interferes with one or more of the other members.[6]

In many of the tables that follow, the total of productive labor, fatigue allowance, and wait time are added in a column called Total labor. Total labor is the total labor input, expressed in man-hours or man-minutes, required for the performance of an operation or cycle of operations.

The time required to perform an operation also may be expressed as elapsed time. Elapsed time is especially important in the receiving cycle of operations, because it determines the length of unloading time of a highway truck or railroad car. Elapsed time is the length of time in minutes or hours from the beginning to the end of an operation or cycle of operations.

## UNLOADING FROM RAILROAD CARS AND PLACING INTO STORAGE

Unloading railroad cars and placing into storage a wide variety of different package types make up one of the basic operations in public refrigerated warehouses. Since most multistory warehouses surveyed were limited by low ceilings, small doors, and low elevators capacities, the 4-wheel platform hand truck was the principal type of handling equipment used.

### Multistory Warehouses

#### HAND TRUCKS

The hand truck has been for many years one of the principal types of handling equipment used in public refrigerated warehouses. It is convenient for practically all commodities, and the capital investment is relatively small.

The hand truck was probably the most important single item of handling equipment in the warehouses studied, particularly in multistory operations.

Cars were unloaded by hand-stacking containers on hand trucks. For the first few unit loads, the hand trucks were spotted on the dock at the car door (fig. 12). After sufficient space was available in the car, the hand trucks were pushed inside. Subsequent hand trucks were spotted for loading as closely as possible to the work face inside the car. The loaded hand trucks were moved out of the car to the platform, where the

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[6] Interference usually occurs in an area with narrow aisles, at a doorway, or at a bridge plate.

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Figure 12.--Loading a hand truck spotted on the platform at the door of a refrigerated railroad car.

containers were lot-stamped. The loaded hand trucks were transported to, and then pushed onto, the elevator (fig. 13). They were taken to the proper floor by the elevator, pushed into storage rooms through manually operated storage room doors, and spotted at the stacks. The containers were then removed from the hand trucks and handstacked for storage.

Transportation distances varied considerable during receiving at different plants. For this analysis, the transportation distance from the refrigerator car to the elevator was standardized at 145 feet; the elevator travel, 48 feet; and the transportation from the elevator to the storage position, 140 feet.

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Figure 13.--Pulling a loaded hand truck off an elevator.

Table 3 shows the labor and equipment requirements per ton for unloading four types of containers from railroad cars and placing them into storage in multistory warehouses by use of hand trucks, and handstacking to an average height of 9 feet. For 32-pound cans, 0.524 man-hour, per ton were required; for 32-pound cartons, 0.566 man-hour; for 101-pound bags, 0.445 man-hour, and for 200-pound beef hindquarters, 0.975 man-hour. Equipment requirements ranged from 0.510 machine-hour for 101-pound bags to 1.172 machine hours for 200-pound beef hindquarters.

**TABLE 3.--Labor and equipment required to unload 1 ton of 4 specified package types from railroad cars and place in storage in multistory warehouses by use of hand trucks[1]**

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | | 200-pound carcasses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open carrier, prepare to unload (secure hand truck: 20 feet) | 2 | 0.009 | 0.009 | 0.018 | 0.011 | 0.011 | 0.021 | 0.011 | 0.011 | 0.022 | 0.015 | 0.015 | 0.029 |
| Handstack, hand truck: | | | | | | | | | | | | | |
| (b) On dock | 2 | .016 | .033 | .033 | .015 | .030 | .031 | .008 | .016 | .015 | .015 | .031 | .031 |
| (c) Inside car | 2 | .073 | [3] .217 | .145 | .082 | [3] .247 | .164 | .062 | .124 | .124 | .129 | .258 | .258 |
| (d) Close car | 2 | .006 | .006 | .011 | .006 | .006 | .013 | .007 | .007 | .013 | .009 | .009 | .018 |
| (e) Lot stamp, transport loads to elevator (145 feet) | 1 | .076 | .076 | .077 | .082 | .082 | .082 | .059 | .059 | .059 | .143 | .143 | .143 |
| (f) Elevator transport (48 feet) | 1 | .041 | .124 | .041 | .041 | .124 | .042 | .041 | .123 | .041 | .110 | .330 | .110 |
| (g) Transport to storage room (140 feet), handstack in storage | 2 | .099 | .199 | .199 | .107 | .214 | .213 | .085 | .170 | .171 | .193 | .386 | .386 |
| Total | | .320 | .664 | .524 | .344 | .714 | .566 | .273 | .510 | .445 | .614 | 1.172 | .975 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296; bags, 400, and carcasses, 150.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons; bags, 20.2 tons, and carcasses, 15 tons.
Unit loads per carload equivalent: Cans, 30; cartons, 26; bags, 25, and carcasses, 50.
Packages per unit load: Cans, 51; cartons, 50; bags, 16, and carcasses, 3.
Unit load stacking: Cans, 17 by 3 tiers; cartons, 10 by 5 tiers, bags, 4 by 4 tiers, and 3 carcasses per hand truck.
Loads from dock: Cans, 4; cartons, 3; bags, 3; and carcasses, 6.
Loads from inside car: Cans, 26; cartons, 23; bags, 22, and carcasses, 44.

[2] Equipment required: Operation (a) 1 bridge plate; (b) 1 bridge plate, one 30-inch by 66-inch hand truck; (c) 1 bridge plate, 1 hand truck; (d) 1 bridge plate; (e) 1 hand truck; (f) one 3-ton elevator, 2 hand trucks; (g) 2 hand trucks. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

[3] One bridge plate and 2 hand trucks.

TABLE 4.--Comparative labor and equipment costs per ton for unloading from railroad cars and placing into storage in multistory warehouses four types of containers by use of hand trucks[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans | 0.320 | [3] 0.664 | 0.524 | 0.07 | 0.76 | 0.83 | 0.96 |
| Cartons | .344 | [4] .714 | .566 | .07 | .82 | .89 | 1.03 |
| Bags | .273 | [5] .510 | .445 | .07 | .65 | .72 | .83 |
| Carcasses | .614 | [6] 1.172 | .975 | .18 | 1.41 | 1.59 | 1.84 |

[1] Transportation distances were standardized at 145 feet from car to elevator, 48 feet elevator transport, and 140 feet elevator to stacking point.
[2] Computed from "current" wage rates.
[3] Bridge plate, 0.103 machine-hour; 30 hand trucks, 0.520 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.664 machine-hour.
[4] Bridge plate, 0.114 machine-hour; 26 hand trucks, 0.559 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.714 machine-hour.
[5] Bridge plate, 0.088 machine-hour, 25 hand trucks, 0.381 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.510 machine-hour.
[6] Bridge plate, 0.168 machine-hour; 50 hand trucks, 0.894 machine-hour; 3-ton elevator, 0.110 machine-hour; total 1.172 machine hours.

The elapsed hours per ton for each part of the unloading operation for four container types also are shown in table 3. The elapsed time for unloading a car in hours per ton was determined by adding the elapsed time for elements a, b, c, and d as shown in table 3. These elapsed times were 0.104 hour for cans, 0.114 hour for cartons, 0.088 hour for bags, and 0.168 hour for beef hindquarters. When the elapsed times for operation elements e, f, and g were added, the time required to unload and to place the containers into storage was obtained. Thus, the rates per ton at which the container types were handled were: 0.320 hour for cans, 0.344 hour for cartons, 0.273 hour for bags, and 0.614 hour for beef hindquarters.

Table 4 shows the labor and equipment requirements per ton and the equipment and labor dollar cost per ton with current wage rates. Bag-type containers were handled at the lowest cost, $0.72 per ton. Carcasses had the highest cost, $1.59 per ton.

This materials-handling method was used in most of the multistory cold storage warehouse in the industry. The method has the advantage of requiring relatively few pieces of simple equipment with low maintenance cost. When used in conjunction with high stacking in the storage rooms, it produced a high percentage of space utilization.

When speed is the prime requisite in unloading or stacking in the storage rooms, the number of workers in the unloading crews can be increased, although this results in increased costs per ton, as would be expected. Speed of the elevator operations can be slightly increased by placing an additional handler on the elevator to help the operator push loads on and off. This was done in some of the selected warehouses where the elevators had platforms large enough to take four or more trucks at a time. Obviously, the extra worker on the elevator increases the total cost.

## PALLETS, HAND TRUCKS, AND INDUSTRIAL FORKLIFT TRUCKS

Unloading with pallets, four-wheel hand trucks, and industrial forklift trucks at multistory warehouses involved some of the same elements as unloading with four-wheel hand trucks alone (fig. 14). The empty pallet was placed on the bed of the hand truck and moved to the car door (fig. 15). Here the packages were placed on the pallet. Only the first loads

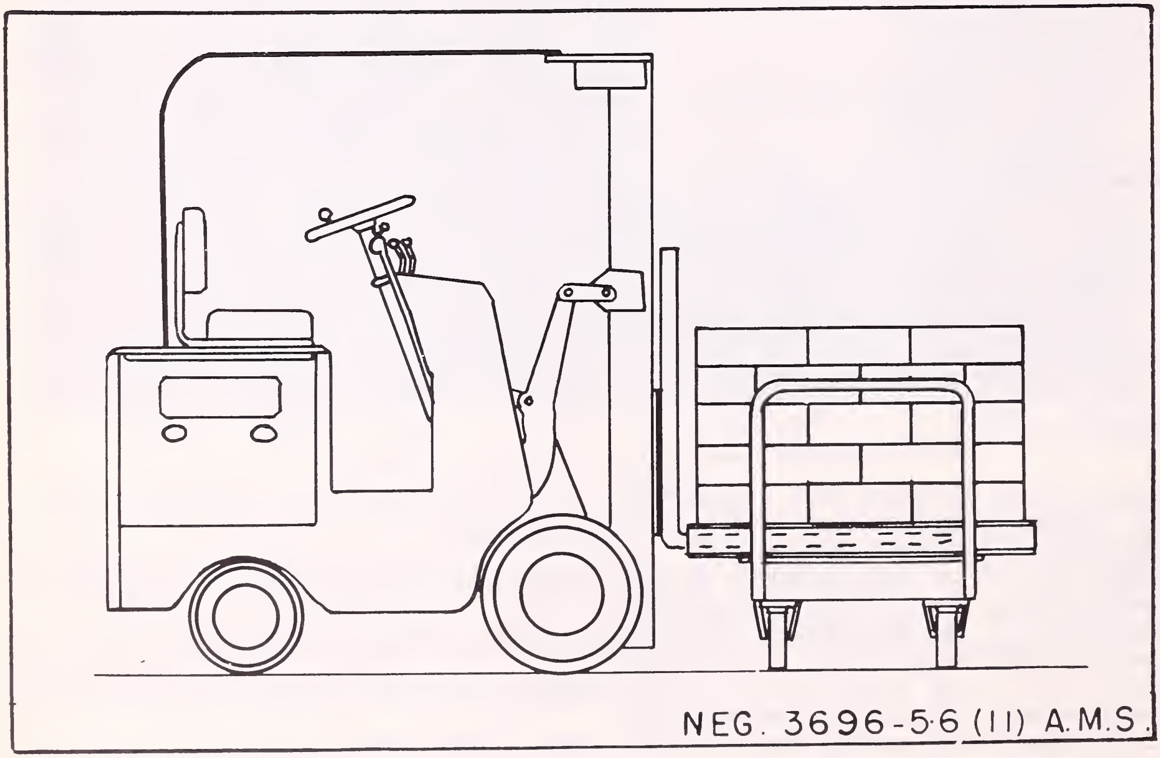


Figure 14.--Removing a pallet load from a hand truck with an industrial forklift truck.

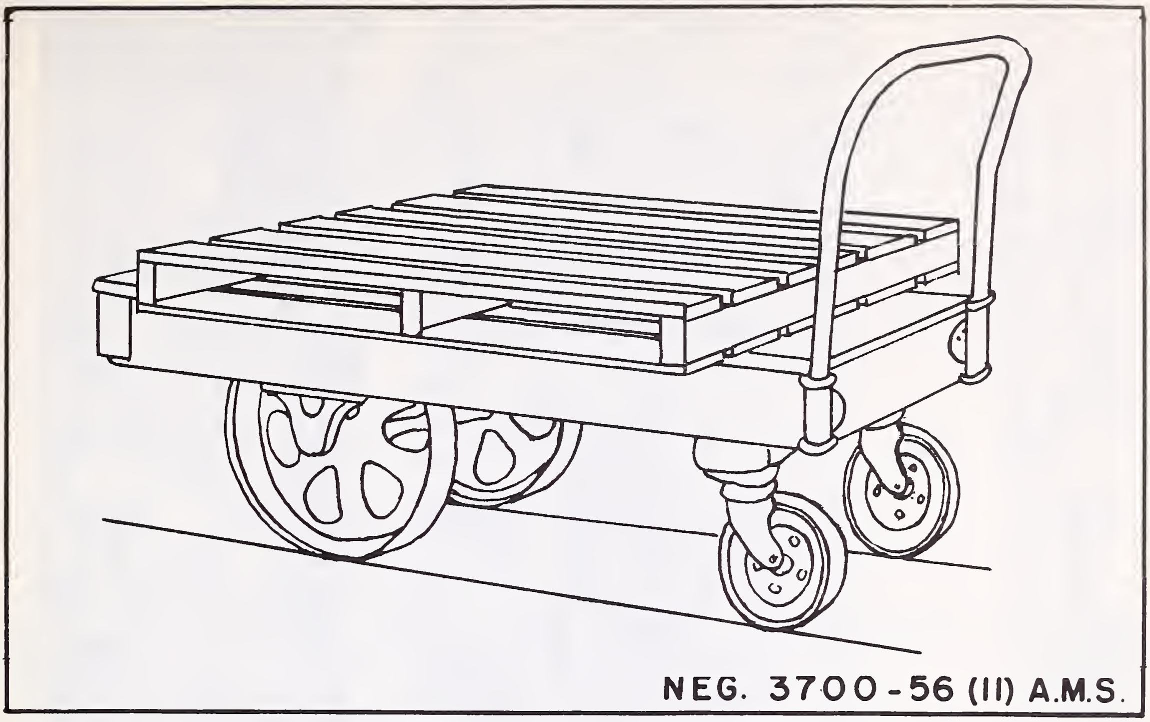


Figure 15.--Pallet on hand truck.

were palletized at the car door, and, as space became available, the pallet-loaded hand trucks were moved inside the car to the work face, eliminating the carrying of each package to the door of the refrigerator car. The same procedure was used as for the hand truck in getting the loaded pallet to the stacking point. At the stacking point in the storage, the forklift truck was used to pick up the pallet load from the bed of the truck and stow it in the cooler or freezer (fig. 16). In the selected multistory warehouse in which an industrial forklift was used for stacking, the ceiling height restricted the stacking of loaded pallets to two tiers.

Table 5 shows the labor and equipment requirements per ton for unloading three types of containers from railroad cars and placing them into multistory warehouse storage by means of pallets on hand trucks and industrial forklift trucks. Animal carcasses were not transported on pallets in the multistory warehouses observed. The labor requirements per ton for the three container types studied did not differ greatly. The equipment requirements were the lowest for bags and the highest for cartons.

While the total elapsed time in hours per ton was the same for cans and bags, placing cartons into storage consumed slightly more time in hours per ton handled. Cartons were placed into storage more quickly than either cans or bags, but they required somewhat more time to remove from the rail car than either cans or bags; thus, the total elapsed time for the entire job was somewhat greater for cartons.

Table 6 shows that the three container types were handled at approximately the same cost. Cartons had the highest cost at $0.77 per ton. At the assumed wage rates, these relations were about the same.

In this method of handling, one element was placing an empty pallet on a hand truck. In most plants where this method was employed, it was not always necessary to perform this element. Frequently empty hand trucks were returned from the loading dock area, and consequently carried an empty pallet, eliminating the need for placing the pallet.

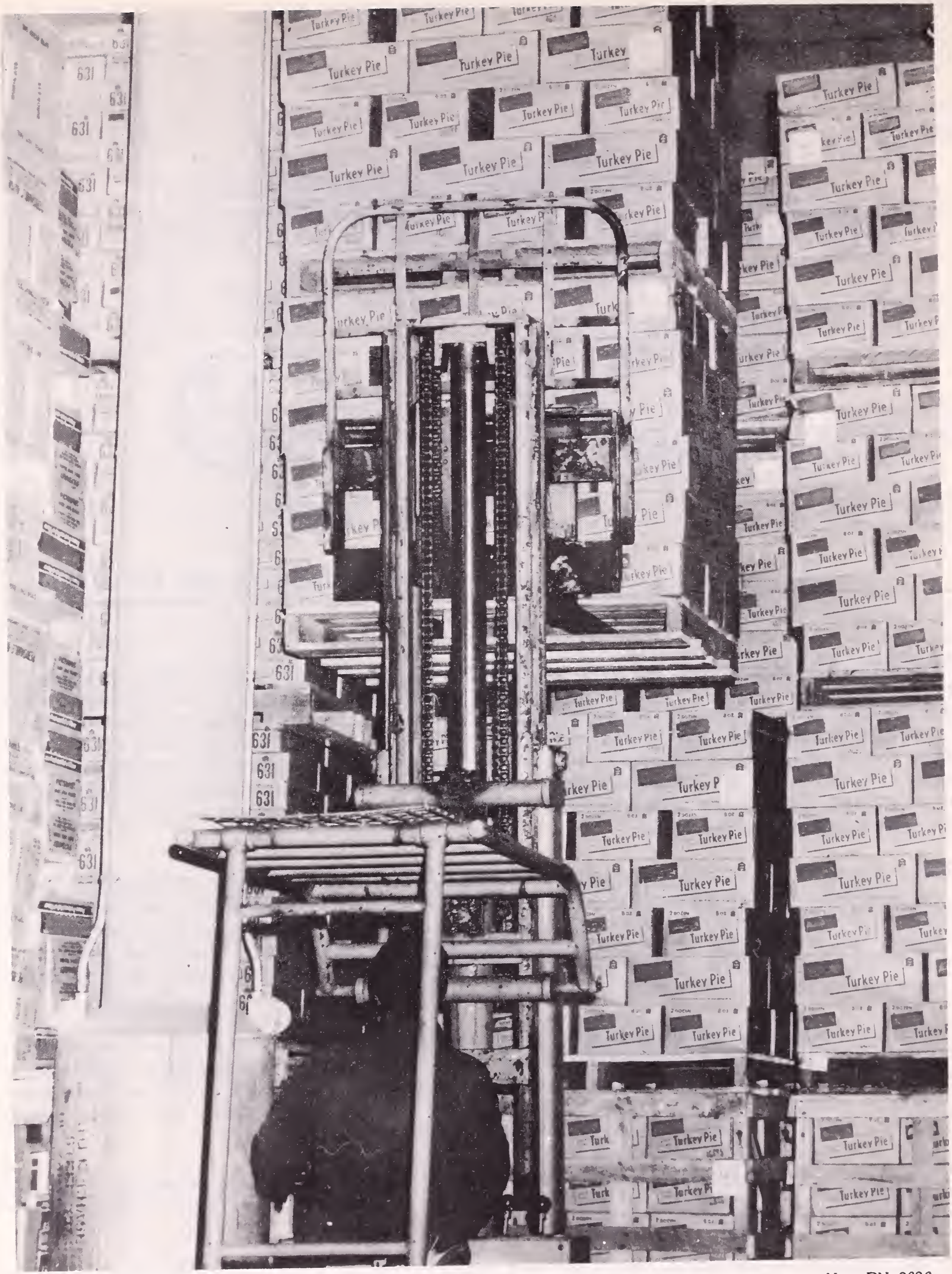


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Figure 16.--A forklift truck stacking pallet load in a freezer room.

TABLE 5.--Labor and equipment required to unload one ton from railroad cars and place in storage in multistory warehouses by specified package types and by use of pallets on hand trucks and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open carrier, prepare to unload (secure hand truck: 20 feet)..... | 2 | 0.009 | 0.009 | 0.018 | 0.011 | 0.011 | 0.022 | 0.011 | 0.011 | 0.022 |
| Handstack, pallet on hand truck | | | | | | | | | | |
| (b) On dock.......................... | 2 | .018 | .053 | .035 | .020 | .060 | .040 | .008 | .024 | .016 |
| (c) Inside car....................... | 2 | .076 | .379 | .152 | .083 | .416 | .166 | .074 | [3] .222 | .148 |
| (d) Close car.......................... | 2 | .005 | .005 | .010 | .006 | .006 | .012 | .006 | .006 | .012 |
| (e) Lot stamp, transport loads to elevator (145 feet)............. | 1 | .071 | .142 | .071 | .074 | .149 | .074 | .064 | .128 | .064 |
| (f) Elevator transport (48 feet)........ | 1 | .038 | .189 | .038 | .035 | .175 | .035 | .044 | .220 | .044 |
| (g) Transport to storage room (140 feet) | 1 | .052 | .104 | .052 | .047 | .094 | .047 | .060 | .120 | .060 |
| (h) Stack in storage room.............. | 2 | .023 | .069 | .046 | .021 | .063 | .042 | .025 | .075 | .050 |
| Total........................ | | .292 | .950 | .422 | .297 | .974 | .438 | .292 | .806 | .416 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296, and bags, 400.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons, and bags, 20.2 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22 and bags, 27.
Packages per unit load: Cans, 54; cartons, 60; and bags, 15.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 5 tiers.
Loads from dock: Cans, 4; cartons, 3, and bags, 3.
Loads from inside car: Cans, 24; cartons, 19, and bags, 24.

[2] Equipment required: Operation (a) 1 bridge plate; (b) 1 bridge plate, one 40-inch by 48-inch pallet, one 30-inch by 66-inch hand truck; (c) 1 bridge plate, 2 pallets, 2 hand trucks; (d) 1 bridge plate; (e) 1 pallet, 1 hand truck; (f) one 3-ton elevator, 2 pallets, 2 hand trucks; (g) 1 pallet, 1 hand truck; (h) one 3,000-pound forklift truck, 1 pallet, 1 hand truck. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

[3] One bridge plate, 1 pallet, and 1 hand truck.

## PALLETS, HAND TRUCKS, AND WALKIE-TYPE INDUSTRIAL HIGH-LIFT TRUCK

This method is similar to the method just previously described, except that walkie-type industrial high-lift trucks are used instead of industrial forklift trucks to stack the pallets in the storage rooms (fig. 17). Labor and equipment requirements are shown in table 7 for three types of containers. Animal carcasses were not unloaded by this method in the warehouses studied and, therefore, are not included in the analysis for this method. All three package types were unloaded and placed in storage with about the same number of man hours per ton. Cans and bags required almost identical amounts of labor, while cartons were slightly higher. For all commodities, the operation of handstacking the packages on pallets required more labor than any other operational element. Equipment requirement per ton was the lowest, 0.842 machine-hour, for bags; the highest, 0.998 machine-hour, for cartons. The elapsed time for performing this operation was about the same for each of the three package types.

As shown in table 8, equipment costs for all three container types amounted to $0.13 per ton. Labor costs per ton were $0.64 for cans and bags and $0.66 for cartons. Total costs, therefore, amounted to $0.77 per ton for cans and bags and $0.79 for cartons. At the assumed wage rates, the costs were increased by $0.11 per ton for each package type.

The equipment costs for this method were somewhat lower than for the pallet, hand truck, and industrial forklift truck method; however, labor rates offset this advantage slightly when substituting the walkie-type industrial high-lift truck for the industrial fork-lift truck. In most warehouses where the described method of unloading was used, empty pallets carried on hand trucks were obtained from the loading platform; therefore, as noted in the previously discussed methods, the element of placing the pallet on a hand truck was not always required in this operation.

TABLE 6.--Comparative labor and equipment costs per ton for unloading from railroad cars and placing in storage in multistory warehouses three types of containers by use of pallets, hand trucks, and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.292 | [3]0.950 | 0.422 | 0.14 | 0.61 | 0.75 | 0.86 |
| Cartons.... | .297 | [4].974 | .438 | .13 | .64 | .77 | .88 |
| Bags....... | .292 | [5].806 | .416 | .14 | .61 | .75 | .85 |

[1] Transportation distances were standardized at 145 feet from car to elevator, 48 feet elevator transport, and 140 feet elevator to stacking point.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.106 machine-hour; 28 (40-by 48-inch) pallets, 0.392 machine-hour; 28 hand trucks, 0.392 machine-hour; 3-ton elevator, 0.037 machine-hour; 3,000-pound industrial forklife truck, 0.023 machine-hour; total, 0.950 machine-hour.

[4] Bridge plate, 0.121 machine-hour; 22 (40-by 48-inch) pallets, 0.398 machine-hour; 22 hand trucks, 0.399 machine-hour; 3-ton elevator, 0.35 machine-hour; 3,000-pound industrial forklift truck, 0.021 machine-hour; total, 0.974 machine-hour.

[5] Bridge plate, 0.069 machine-hour; 27 (40-by 48-inch) pallets, 0.334 machine-hour; 27 hand trucks, 0.334 machine-hour; 3-ton elevator, 0.044 machine-hour; 3,000-pound industrial forklift truck, 0.025 machine-hour; total, 0.806 machine-hour.

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Figure 17.--Stacking a pallet load in the storage room with a walkie-type industrial high-lift truck.

TABLE 7.--Labor and equipment required to unload 1 ton of 3 specified package types from railroad cars and place in storage in multistory warehouses by use of pallets, hand trucks, and a walkie-type industrial high-lift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open car, prepare to unload (secure hand truck: 20 feet)..... | 2 | 0.009 | 0.009 | 0.018 | 0.011 | 0.011 | 0.022 | 0.011 | 0.011 | 0.022 |
| Handstack, pallet on hand truck | | | | | | | | | | |
| (b) On dock........................ | 2 | .018 | .054 | .037 | .020 | .060 | .040 | .008 | .025 | .016 |
| (c) Inside car...................... | 2 | .074 | .373 | .148 | .084 | .417 | .167 | .073 | [3] .220 | .146 |
| (d) Close car......................... | 2 | .006 | .006 | .012 | .006 | .006 | .012 | .007 | .007 | .014 |
| (e) Lot stamp, transport loads to elevator (145 feet)............. | 1 | .071 | .142 | .071 | .074 | .148 | .074 | .064 | .128 | .064 |
| (f) Elevator transport (48 feet)........ | 1 | .039 | .195 | .039 | .035 | .175 | .035 | .044 | .220 | .044 |
| (g) Transport to storage room (145 feet)........................ | 1 | .052 | .104 | .052 | .047 | .094 | .047 | .060 | .120 | .060 |
| (h) Stack in storage room.............. | 2 | .032 | .096 | .064 | .029 | .087 | .058 | .037 | .111 | .074 |
| Total........................ | | .301 | .979 | .441 | .306 | .998 | .455 | .304 | .842 | .440 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296, and bags, 400.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons, and bags, 20.2 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22, and bags, 27.
Packages per unit load: Cans, 54; cartons, 60, and bags, 15.
Unit load of stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 5 tiers.
Loads from dock: Cans, 4; cartons, 3, and bags, 3.
Loads from inside car: Cans, 24; cartons, 19, and bags, 24.

[2] Equipment required: Operation (a) 1 bridge plate; (b) one 30-inch by 66-inch hand truck, one 40-inch by 48-inch pallet, 1 bridge plate; (c) 2 hand trucks, 2 pallets, 1 bridge plate; (d) 1 bridge plate; (e) 1 hand truck, 1 pallet; (f) one 3-ton elevator, 2 hand trucks, 2 pallets; (g) 1 hand truck, 1 pallet; (h) one 2,000-pound, walkie-type, forklift truck, 1 hand truck, 1 pallet. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

[3] One bridge plate, 1 pallet, and 1 hand truck.

TABLE 8.--Comparative labor and equipment costs per ton for unloading from railroad cars and placing in multistory warehouses three types of containers by use of pallets, hand trucks, and walkie-type industrial high-lift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.301 | [3]0.979 | 0.441 | 0.13 | 0.64 | 0.77 | 0.88 |
| Cartons.... | .306 | [4].998 | .455 | .13 | .66 | .79 | .90 |
| Bags....... | .304 | [5].842 | .440 | .13 | .64 | .77 | .88 |

[1] Transportation distances were standardized at 145 feet from car to elevator, 48 feet elevator transport, and 140 feet elevator to stacking point.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.106 machine-hour; 28 (40- by 48-inch) pallets, 0.401 machine-hour; 28 hand trucks, 0.401 machine-hour; 3-ton elevator, 0.039 machine-hour; 2,000-pound walkie-type industrial forklift truck, 0.032 machine-hour; total, 0.979 machine-hour.

[4] Bridge plate, 0.122 machine-hour; 22 (40- by 48-inch) pallets, 0.406 machine-hour; 22 hand trucks, 0.406 machine-hour; 3-ton elevator 0.035, machine-hour; 2,000-pound walkie-type industrial forklift truck, 0.029 machine-hour; total, 0.998 machine-hour.

[5] Bridge plate, 0.069 machine-hour; 27 (40- by 48-inch) pallets, 0.346 machine-hour; 27 hand trucks, 0.346 machine-hour; 3-ton elevator, 0.044 machine-hour; 2,000-pound walkie-type industrial forklift truck, 0.037 machine-hours; total, 0.842 machine-hour.

## HAND TRUCKS AND WALKIE-TYPE INDUSTRIAL TRACTOR

In one method studied, a walkie-type industrial tractor was used with hand trucks to unload commodities from railroad cars and place them in storage. Actually, the method was essentially the same as that described earlier for hand trucks, the only difference being that the hand trucks were towed with the walkie-type industrial tractor from the car to the elevator (fig. 7).

Table 9 shows the labor and equipment requirements for unloading and placing cans and cartons into storage by use of hand trucks and a walkie-type industrial tractor. Bags and carcasses are not included for this method because of insufficient warehouse receiving volume during the period of these observations. For the two package types studied, about 37 percent of all the labor used in this operation was used in manually transporting the loaded hand trucks from the elevator to the stacking point and handstacking the packages. Labor requirements per ton amounted to 0.536 man-hour for 32-pound cans and 0.578 man-hour for 32-pound cartons. Equipment time and elapsed time also were higher for cartons than for cans.

Hand trucks with a walkie-type industrial tractor were less efficient than hand trucks alone; however, the industrial tractor does much to decrease worker fatigue and it makes a definite contribution to worker morale.

The labor and equipment costs for the hand truck and walkie-type industrial tractor method of unloading a rail car and placing into storage one ton of cans or cartons are shown in table 10. From these data and those shown in table 4, it can readily be seen that there is no cost advantage in using a walkie-type industrial tractor to tow hand trucks instead of manually pushing the hand trucks.

TABLE 9.--Labor and equipment required to unload 1 ton from railroad cars and place in storage in multistory warehouses by specified package types and by use of hand trucks and a walkie-type industrial tractor[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | |
|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open car, prepare to unload (secure hand truck: 20 feet) | 2 | 0.009 | 0.009 | 0.018 | 0.011 | 0.011 | 0.022 |
| Handstack, hand truck | | | | | | | |
| (b) On dock | 2 | .017 | .034 | .034 | .016 | .032 | .032 |
| (c) Inside car | 2 | .072 | .218 | .144 | .082 | .246 | .164 |
| (d) Close car | 2 | .006 | .006 | 012 | .006 | .006 | .012 |
| (e) Lot stamp | 1 | .031 | .031 | .031 | .036 | .036 | .036 |
| (f) Tow loads to elevator with walkie-type electric tractor (145 feet) | 1 | .058 | .116 | .058 | .058 | .116 | .058 |
| (g) Elevator transport (48 feet) | 1 | .041 | .123 | .041 | .042 | .125 | .042 |
| (h) Manually transport to storage room (140 feet) and handstack | 2 | .099 | .198 | .198 | .106 | .212 | .212 |
| Total | | .333 | .735 | .536 | .357 | .784 | .578 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500, and cartons, 1,296.
Total gross weight of packages: Cans, 24 tons, and cartons, 20.73 tons.
Unit loads per carload equivalent: Cans, 30, and cartons, 26.
Packages per unit load: Cans, 51, and cartons, 50.
Unit load stacking: Cans, 17 by 3 tiers, and cartons, 10 by 5 tiers.
Loads from dock: Cans, 4, and cartons, 3.
Loads from inside car: Cans, 26, and cartons, 23.

[2] Equipment required: Operation (a) 1 bridgeplate; (b) one 30-inch by 66-inch hand truck, 1 bridgeplate; (c) 2 hand trucks, 1 bridgeplate; (d) 1 bridgeplate; (e) 1 hand truck; (f) 1 hand truck, one 700-pound, walkie-type, industrial tractor; (g) 2 hand trucks, one 3-ton elevator; (h) 2 hand trucks. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

TABLE 10.--Comparative labor and equipment costs per ton for unloading from railroad cars and placing into storage in multistory warehouses two types of packages by use of hand trucks and a walkie-type industrial tractor[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.333 | [3]0.735 | 0.536 | 0.08 | 0.78 | 0.86 | 0.99 |
| Cartons.... | .357 | [4].784 | .578 | .08 | .84 | .92 | 1.06 |

[1] Transportation distances were standardized at 145 feet from car to elevator, 48 feet elevator transport, and 140 feet elevator to stacking point.
[2] Computed from "current" wage rates.
[3] Bridge plate, 0.105 machine-hour; 30 hand trucks, 0.531 machine-hour; 700-pound walkie-type industrial tractor, 0.058 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.735, machine-hour.
[4] Bridge plate, 0.115 machine-hour; 26 hand trucks, 0.570 machine-hour; 700-pound walkie-type industrial tractor, 0.058 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.784 machine-hour.

## HAND TRUCKS AND GRAVITY ROLLER CONVEYOR

Unloading and placing commodities in storage by use of hand trucks and gravity roller conveyors was done only to a limited degree in the selected warehouses. Because cans, bags, and carcasses either will not readily move on gravity conveyors or might fall off, the analysis here is confined to the handling of cartons.

After the car doors were opened, a section of gravity roller conveyor was set up in the doorway of the car, with one end extending over the platform (fig. 4). For the first few loads, the hand trucks were spotted on the platform at the end of the conveyor. Containers were placed on the car end of the conveyor by one worker and were removed from the platform end of the conveyor by another worker who handstacked the containers on the hand trucks. After sufficient space had been opened in the car for the entrance of a hand truck, the section of gravity roller conveyor was removed. Subsequent trucks were pushed to the work face inside the car, containers were loaded on the trucks, and the loads pushed out onto the platform. The containers were then lot stamped. The loaded hand trucks were pushed to and onto the elevator and were taken on the elevator to the storage floor. Here they were pushed through manually operated doors into the storage rooms and spotted at the stacks. The containers were handstacked in storage position.

Labor and equipment requirements are given in table 11 for this method. The elapsed time required was 0.355 hour per ton, equipment time needed was 0.769 machine-hour, and productive labor required amounted to 0.587 man-hour. In this method, placing packages on the conveyor and taking them off and placing in storage required 73 percent of the productive labor.

Table 12 shows the labor and equipment costs per ton for unloading and placing in storage 32-pound cartons. Labor costs were $0.85 per ton, and equipment costs were $0.07 per ton, totaling $0.92 per ton for labor and equipment at current wage levels. At the assumed wage rate, these total costs amounted to $1.07 per ton.

TABLE 11.--Labor and equipment required to unload 1 ton of 32-pound cartons from railroad cars and place in storage in multistory warehouses by use of hand trucks and a gravity roller conveyor[1]

| Operation element[2] | Workers | Elapsed time | Equipment | Productive labor |
|---|---|---|---|---|
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open car, prepare to unload (secure roller conveyor: 50 feet; secure hand truck: 20 feet)................ | 2 | 0.012 | 0.024 | 0.024 |
| (b) Handstack containers on truck spotted on dock at end of roller conveyor... | 2 | .024 | .072 | .048 |
| (c) Remove roller conveyor (60 feet)...... | 2 | .001 | .002 | .002 |
| (d) Handstack containers on truck spotted at work face inside car............ | 2 | .082 | .246 | .164 |
| (e) Close car............................ | 2 | .006 | .006 | .012 |
| (f) Lot stamp, transport loaded trucks to elevator (145 feet).............. | 1 | .082 | .082 | .082 |
| (g) Elevator transport (48 feet).......... | 1 | .041 | .123 | .041 |
| (h) Transport to storage room, (140 feet), and handstack............... | 2 | .107 | .214 | .214 |
| Total............................ | | .355 | .769 | .587 |

[1] Loading data: Cartons per carload equivalent, 1,296; total gross weight of cartons, 20.73 tons; unit loads per carload equivalent, 26; cartons per unit load, 50; unit load stacking, 10 by 5 tiers; unit loads from dock, 3; unit loads from inside car, 23.

[2] Equipment required: Operation (a) 1 bridge plate, one 12-inch-wide by 10-foot gravity roller conveyor; (b) 1 bridge plate, 1 conveyor, 1 hand truck; (c) 1 bridge plate, 1 conveyor; (d) 1 bridge plate, 2 hand trucks; (e) 1 bridge plate; (f) 1 hand truck; (g) 2 hand trucks, one 3-ton elevator; (h) 2 hand trucks. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

TABLE 12.--Comparative labor and equipment costs per ton for unloading from railroad cars and placing into storage in multistory warehouses 32-pound cartons by use of hand trucks and a gravity roller conveyor[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cartons... | 0.355 | [3]0.769 | 0.587 | 0.07 | 0.85 | 0.92 | 1.07 |

[1] Transportation distances standardized at 145 feet from car to elevator, 48 feet of elevator travel, and 140 feet from elevator to storage point.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.125 machine-hour; 12-inch by 10-foot roller conveyor, 0.037 machine-hour; 26 hand trucks, 0.566 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.769 machine-hour.

## COMPARISON OF SELECTED METHODS FOR UNLOADING FROM RAILROAD CARS AND PLACING INTO STORAGE IN MULTISTORY WAREHOUSES

A comparison is presented in table 13 of the several materials-handling methods used in the selected warehouses for which time-study data were collected. The object was to determine the methods now in use that result in the quickest and most economical means of unloading four types of packages from railroad cars and placing them into multistory warehouse storage, with due regard to the normal worker effort required.

Cans.--In the warehouses surveyed, cans and other noncubical rigid types of containers were unloaded and placed into storage most efficiently by use of pallets on hand trucks, and industrial forklift trucks.

It was found that the total cost of unloading a ton of cans was $0.75 when this method was used. This cost was $0.02 per ton less than when a walkie-type industrial high-lift truck was substituted for the industrial forklift truck, $0.08 less than the hand-truck method, and $0.11 less than the method using hand trucks in combination with a walkie-type industrial tractor.

The method employing pallets on hand trucks and stacking with an industrial forklift truck was also the fastest method, requiring 0.292 hour elapsed time per ton. Hand trucks with a walkie-type industrial tractor were the slowest, requiring 0.333 hour elapsed time per ton.

Cartons.--Cartons or crates and other types of cubical rigid containers were unloaded and placed into storage most efficiently, in the warehouses surveyed, in the same manner as cans; that is, by using pallets, hand trucks, and an industrial forklift truck.

A comparison of the five methods of handling cartons revealed that the method described had a cost advantage of $0.02 per ton over the use of pallets, hand trucks, and a walkie-type industrial high-lift truck, and a total cost of $0.77 per ton handled. The method using hand trucks and a walkie-type industrial tractor and the method using hand trucks and gravity conveyors each had a total cost of $0.92 per ton, the highest cost of all methods tested. Costs were $0.89 per ton when using hand trucks alone.

Apparently, there was no cost advantage in using a portable gravity roller conveyor section to unload the first few cartons from the car to clear a space for the hand trucks within the car.

The elapsed times for the different methods of performing the operation of unloading cartons from railroad cars and placing them in storage ranged from a low of 0.297 hour when pallets, hand trucks, and an industrial forklift truck were used, to 0.357 hour when hand trucks and walkie-type industrial tractor were used. The rest of the methods showed elapsed times of 0.306 hour, 0.344 hour, and 0.355 hour.

Bags.--The use of hand trucks in unloading together with hand stacking in storage, was the most economical of the three methods examined for handling bags into storage, showing a cost of $0.72 per ton. The labor advantages of the industrial trucks were overcome when it was considered that the industrial forklift truck of the capacity used could not enter directly into the car, because the floor racks of the cars generally would not support the weight of the heavy equipment. This introduced another interesting aspect of the use of materials-handling equipment, for when the data are examined (see table 13), it is found that the use of either an industrial forklift truck or a walkie-type high-lift truck in combination with pallets on hand trucks shows higher per-ton costs, i.e. $0.75 and $0.77, respectively, than the use of hand trucks alone when hand stacking of the containers is done at the storage point. The method using hand trucks alone showed the lowest elapsed time, 0.273 hour, which is 7 percent faster than using the method employing the industrial forklift truck to stack the loaded pallets and 11 percent faster than using a walkie-type industrial high-lift truck.

TABLE 13.--Comparative labor and equipment costs per ton for unloading from railroad cars and placing in storage in multistory warehouses four types of packages by use of specified methods and types of equipment[1]

| Container and type of equipment | Elapsed time | Labor and equipment required: Equipment time[2] | Labor and equipment required: Total labor | Labor and equipment costs: Equipment | Labor and equipment costs: Labor[3] | Total cost: Current wages | Total cost: Assumed wages |
|---|---|---|---|---|---|---|---|
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans: | | | | | | | |
| Hand trucks | 0.320 | 0.664 | 0.524 | 0.07 | 0.76 | 0.83 | 0.96 |
| Pallets, hand trucks, and industrial forklift truck | .292 | .950 | .422 | .14 | .61 | .75 | .86 |
| Pallets, hand trucks, and walkie-type industrial high-lift truck | .301 | .979 | .441 | .13 | .64 | .77 | .88 |
| Hand trucks and walkie-type industrial tractor | .333 | .735 | .536 | .08 | .78 | .86 | .99 |
| Cartons: | | | | | | | |
| Hand trucks | .344 | .714 | .566 | .07 | .82 | .89 | 1.03 |
| Pallets, hand trucks, and industrial forklift truck | .297 | .974 | .438 | .13 | .64 | .77 | .88 |
| Pallets, hand trucks, and walkie-type industrial high-lift truck | .306 | .998 | .455 | .13 | .66 | .79 | .90 |
| Hand trucks and walkie-type industrial tractor | .357 | .784 | .578 | .08 | .84 | .92 | 1.06 |
| Hand trucks and gravity roller conveyor | .355 | .769 | .587 | .07 | .85 | .92 | 1.07 |
| Bags: | | | | | | | |
| Hand trucks | .273 | .510 | .445 | .07 | .65 | .72 | .83 |
| Pallets, hand trucks, and industrial forklift truck | .292 | .806 | .416 | .14 | .61 | .75 | .85 |
| Pallets, hand trucks, and walkie-type industrial high-lift truck | .304 | .842 | .440 | .13 | .64 | .77 | .88 |
| Carcasses: | | | | | | | |
| Hand trucks | .614 | 1.172 | .975 | .18 | 1.41 | 1.59 | 1.84 |

[1] Transportation distances were standardized at 145 feet from car to elevator, 48 feet elevator transport, and 140 feet elevator to stacking point.
[2] For equipment time, see tables 3, 5, 7, 9, and 11.
[3] Based on "current" wage rates.

TABLE 14.--Labor and equipment required to unload 1 ton of 4 specified package types from railroad cars and place in storage in single-story warehouses by use of pallets and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans: Elapsed time | 32-pound cans: Equipment | 32-pound cans: Productive labor | 32-pound cartons: Elapsed time | 32-pound cartons: Equipment | 32-pound cartons: Productive labor | 101-pound bags: Elapsed time | 101-pound bags: Equipment | 101-pound bags: Productive labor | 200-pound carcasses: Elapsed time | 200-pound carcasses: Equipment | 200-pound carcasses: Productive labor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open car, prepare to unload | 2 | 0.009 | 0.009 | 0.018 | 0.011 | 0.011 | 0.022 | 0.011 | 0.011 | 0.022 | 0.015 | 0.015 | 0.030 |
| (b) Secure supply of 12 pallets (150 feet) | 1 | .002 | .004 | .002 | .002 | .004 | .002 | .002 | .005 | .002 | .007 | .013 | .007 |
| Handstack pallet: | | | | | | | | | | | | | |
| (c) On dock | 2 | .018 | .036 | .036 | .019 | .038 | .038 | .009 | .018 | .018 | .016 | .032 | .032 |
| (d) Inside car | 2 | .076 | .152 | .152 | .122 | .244 | .244 | .059 | .118 | .118 | .120 | .240 | .240 |
| (e) Close car | 2 | .006 | .006 | .012 | .006 | .006 | .012 | .007 | .007 | .013 | .009 | .009 | .018 |
| (f) Transport load to stamping and checking (300 feet) | 1 | .032 | .064 | .032 | .029 | .058 | .029 | .031 | .062 | .031 | .090 | .180 | .090 |
| (g) Lot stamp | 1 | .029 | .029 | .029 | .036 | .036 | .036 | .015 | .015 | .015 | .023 | .023 | .023 |
| (h) Transport to storage room (300 feet), and stack | 1 | .057 | .114 | .057 | .052 | .104 | .052 | .052 | .104 | .052 | .157 | .314 | .157 |
| Total | | .229 | .414 | .338 | .277 | .501 | .435 | .186 | .340 | .271 | .437 | .826 | .597 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296; bags, 400 and carcasses, 150.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons; bags, 20.2 tons, and carcasses 15 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22; bags, 23, and carcasses, 50.
Packages per unit load: Cans, 54; cartons, 60; bags, 18, and carcasses, 3.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers; bags, 3 by 6 tiers, and carcasses, 3 per pallet.
Loads from dock: Cans, 4; cartons, 3; bags, 3, and carcasses, 6.
Loads from inside car: Cans, 24; cartons, 19; bags, 20, and carcasses, 44.
[2] Equipment required: Operation (a) 1 bridge plate; (b) one 3,000-pound riding-type, counter-balanced forklift truck, one 40-inch by 48-inch pallet; (c) bridge plate, 1 pallet; (d) 1 bridge plate, 1 pallet; (e) 1 bridge plate; (f) 1 riding-type, counter-balanced forklift truck, 1 pallet; (g) 1 pallet; (h) 1 riding type, counter-balanced forklift truck, 1 pallet. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

Carcasses.--Since the warehouses surveyed did not use any mechanized equipment to unload or stack animal carcasses, it was not possible to make labor or equipment cost comparisons of different handling methods. Table 13 summarizes the figures on handling animal carcasses in the five multistory warehouses by the use of hand trucks only. The handling of animal carcasses, in general, constitutes the most physically arduous of all the warehouse handling tasks, and, since large tonnages are handled, warehousemen will be searching for new mechanical aids or improved techniques for handling this commodity. On the basis of current wages, it cost 84 percent more to handle a ton of carcasses than a ton of cans, 73 percent more than a ton of cartons, and 106 percent more than a ton of bags, even when these were handled by the most expensive handling methods observed.

Figure 18 summarizes the elapsed times for the operation of unloading and placing into storage. The division point of each bar separates the two major portions of the operation so that the time it takes to unload the several types of containers may be compared by each method of handling.

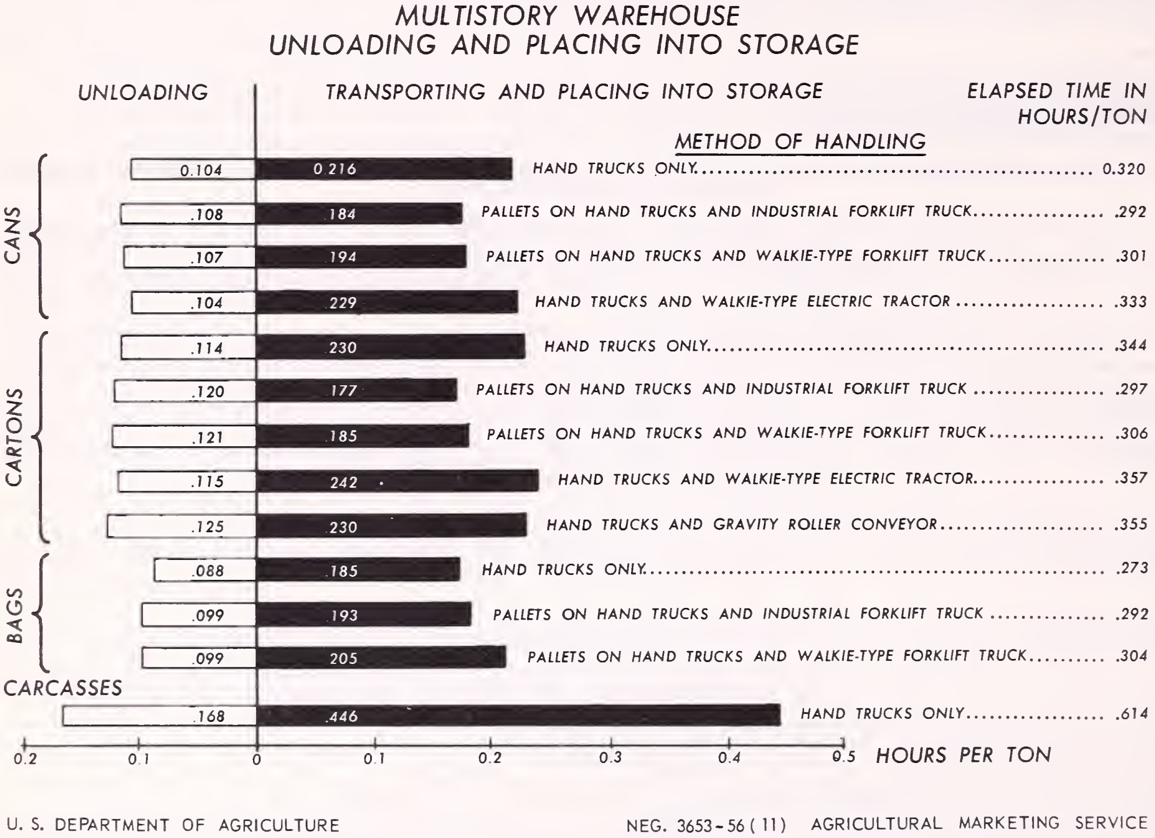
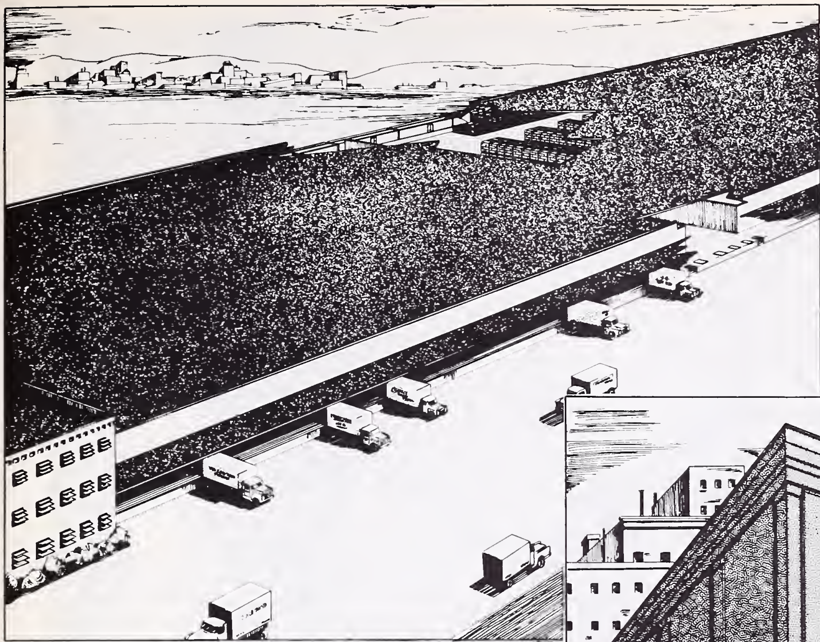



Figure 18.--Elapsed times required to unload one ton from railroad cars and place in storage in multistory warehouses by specified package types and by handling methods.

## Single-Story Warehouse

Most of the larger warehouses in operation today are of multistory design, but in recent years several large single-story warehouses have been constructed. Views of the two types of warehouses (fig. 19) illustrates the differences in layout between single-story and multistory warehouses. The principal advantage of the single-story warehouse is that it lends itself well to use of modern materials-handling methods and equipment, permitting a high degree of efficiency.



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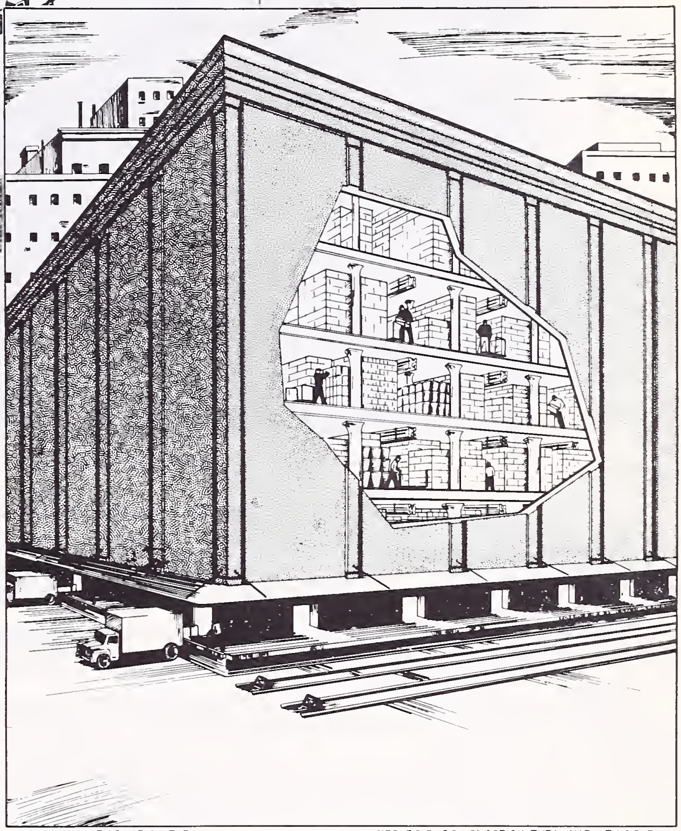

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Figure 19.--Views of single-story and multistory cold storage warehouses.

In the selected single-story warehouse, the storage area consists of a series of storage rooms, separated by an areaway which connects the truck and rail platforms. This spacious throughway is used for the storage of empty pallets and for temporary storage of incoming lots for checking, weighing, and lot stamping. This area is referred to as a "work space" or "work area."

## PALLETS AND AN INDUSTRIAL TRUCK

After the car was opened and made ready to unload, at the warehouse studied, pallets were brought to the door of the car, where the packages were removed from the car and placed on the pallet. Loading outside the car door was done only until space was available inside the car.

After sufficient space had been opened inside the car, the pallets were placed on the car floor racks just inside the car door. In the warehouse in which these studies were conducted, all of the containers were carried from the work face inside the car and hand-stacked on pallets. The loaded pallets were removed from the car door with an industrial forklift truck (fig. 20). The loads were placed in temporary storage in the work areas for lot stamping, checking, and weighing. They were then picked up, transported to the storage rooms through automatic, compressed-air-operated storage room doors, and stacked to a height of 4 tiers by the forklift truck (fig. 21).

Table 14 shows the labor and equipment requirements for this method for four specified package types. Bags required 0.271 man-hour of labor per ton, and 200-pound beef

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Figure 20.--Forklift truck operator picking up a loaded pallet in the railroad car opening.

carcasses required 0. 597 man-hour per ton or more than twice as much. Cans and cartons were unloaded in 0. 338 man-hour and 0. 435 man-hour, respectively.

The total elapsed time in hours for the unloading operation shows that bags were unloaded in 0.186 hour per ton, cans 0.229 hour, cartons 0. 277 hour, and carcasses 0.437 hour.

Table 15 summarizes labor and equipment costs for unloading four selected types of containers from railroad cars and placing them into storage with pallets and an industrial forklift truck. Using current wages and equipment costs, it was found that bags were handled in this operation at a cost of $0. 49 per ton, or 82 percent of the cost of handling cans, 66 percent of the cost of handling cartons, and 43 percent of the cost of handling one ton of animal carcasses.

PALLETS, SEMI-LIVE SKIDS, JACKS, AND INDUSTRIAL FORKLIFT TRUCK

In using this method, after the car had been opened the first pallets were loaded on the platform. That is, the empty pallets were placed on the platform and the packages were manually removed from the car and stacked on the pallet. An industrial truck then picked up the loaded pallet and moved it to the temporary storage area. Up to this point, the operation was the same as the method previously described. As soon as space was available inside the car, the empty pallets were placed on semilive skids, and a jack

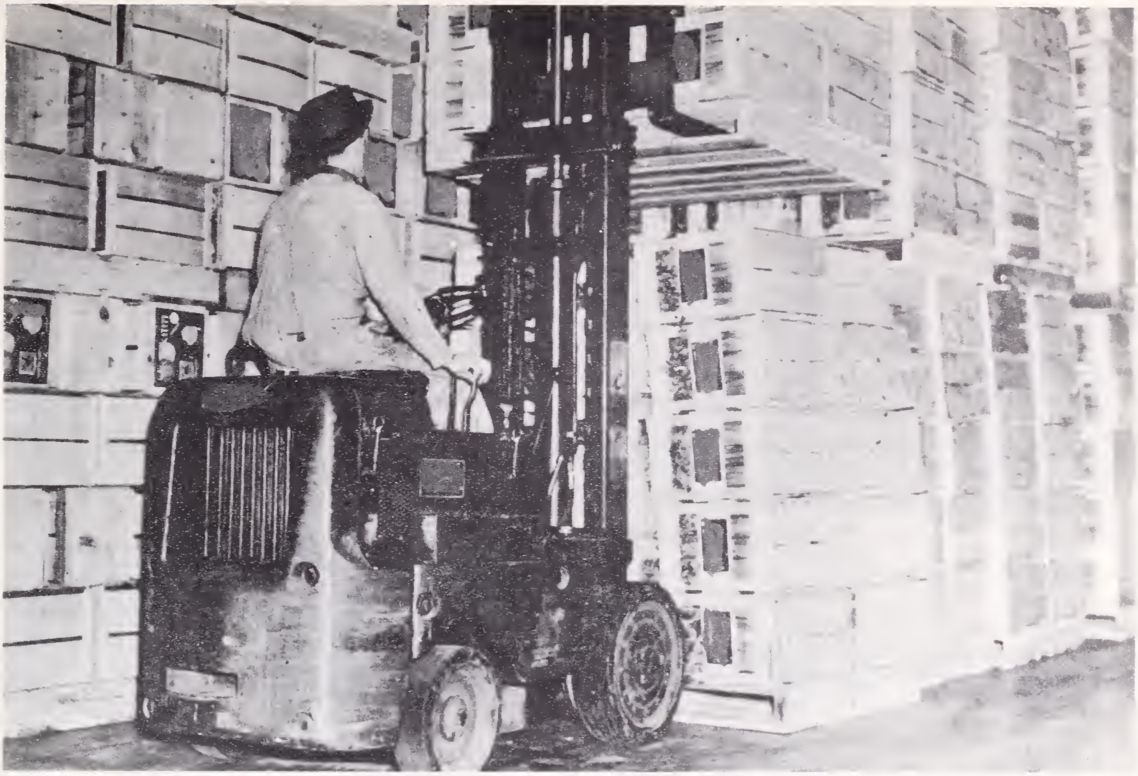

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Figure 21.--Stacking a loaded pallet in a storage room, using an industrial forklift truck.

TABLE 15.--Comparative labor and equipment costs for unloading 1 ton of 4 specified package types from railroad cars and placing into storage in a single-story warehouse by use of pallets and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required: Equipment time | Labor and equipment required: Total labor | Labor and equipment costs: Equipment | Labor and equipment costs: Labor[2] | Total cost: Current wages | Total cost: Assumed wages |
|---|---|---|---|---|---|---|---|
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.229 | [3] 0.414 | 0.338 | 0.10 | 0.50 | 0.60 | 0.68 |
| Cartons.... | .277 | [4] .501 | .435 | .10 | .64 | .74 | .86 |
| Bags....... | .186 | [5] .340 | .271 | .09 | .40 | .49 | .57 |
| Carcasses.. | .437 | [6] .826 | .597 | .25 | .89 | 1.14 | 1.29 |

[1] Transportation distances standardized at 300 feet from car to temporary storage and 300 feet from temporary storage to stacking point.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.109 machine-hour; 28 (40- by 48-inch) pallets, 0.214 machine-hour; 3,000-pound industrial forklift truck, 0.091 machine-hour; total, 0.414 machine-hour.

[4] Bridge plate, 0.158 machine-hour; 22 (40- by 48-inch) pallets, 0.260 machine-hour; 3,000-pound industrial forklift truck, 0.083 machine hour; total, 0.501 machine-hour.

[5] Bridge plate, 0.086 machine-hour; 23 (40- by 48-inch) pallets, 0.169 machine-hour; 3,000-pound industrial forklift truck, 0.085 machine-hour; total, 0.340 machine hour.

[6] Bridge plate, 0.160 machine-hour; 50 (40- by 48-inch) pallets, 0.412 machine-hour; 3,000-pound industrial forklift truck, 0.254 machine-hour; total, 0.826 machine-hour.

coupled to a skid moved it to the work face inside the car (fig. 22). The containers then were hand stacked on the pallet. The semilive skid with its loaded pallet was then taken to the door of the car. The loaded pallets were picked up from the semilive skid inside the car door by an industrial forklift truck. The loads were placed in temporary storage in the work area for lot stamping, weighing, and checking. They were then picked up, transported to the storage rooms, and stacked by the industrial forklift truck.

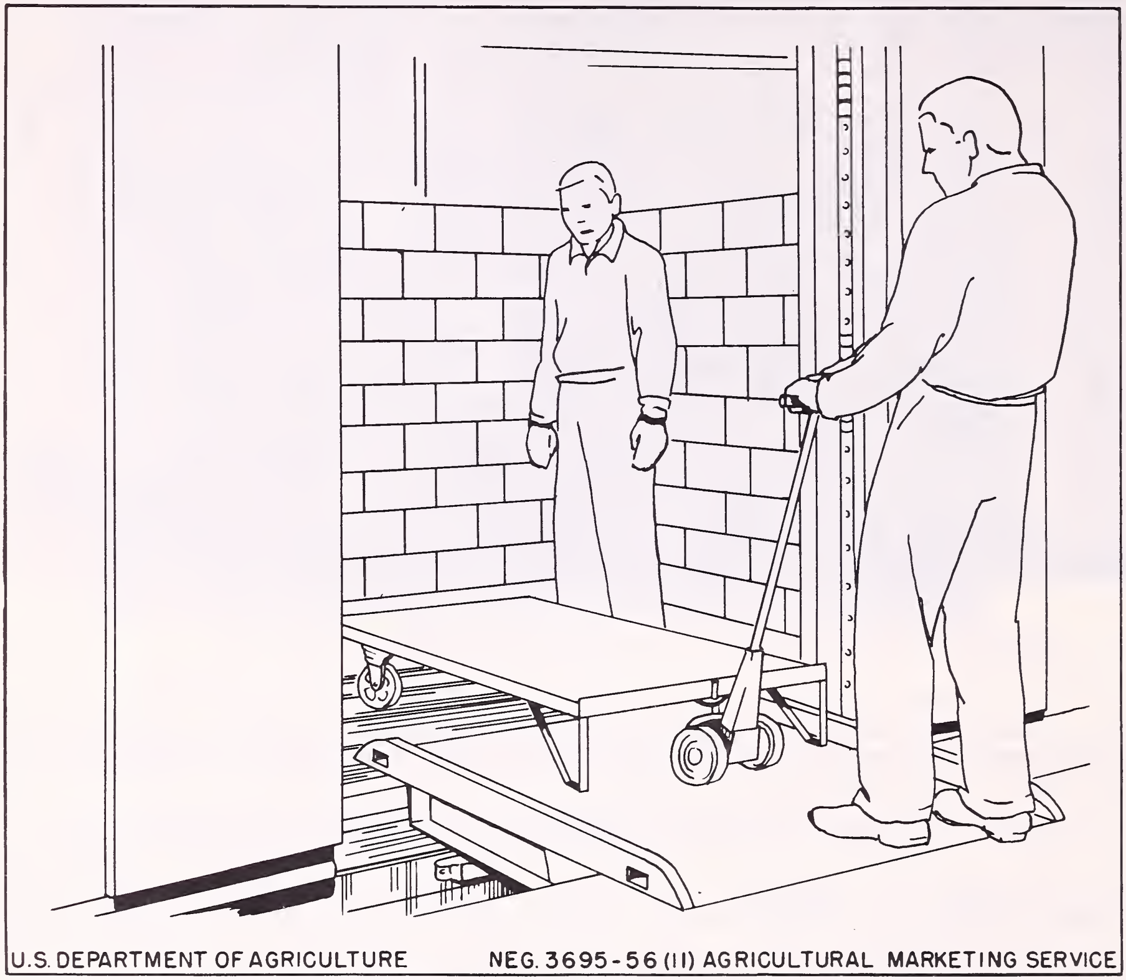


Figure 22.--Semilive skid and jack in railroad car door.

Table 16 shows the labor and equipment requirements to unload 1 ton of cans, cartons, and bags from railroad cars and place them into storage.

Bags, at 0.301 man-hour per ton, required the smallest amount of productive labor for this operation. Cans required 0.338 man-hour and cartons 0.361 man-hour per ton. Similarly, equipment requirements were lowest for bags and highest for cartons.

The elapsed times for performing this operation with the specified method were 0.202 hour for bags, 0.229 for cans, and 0.240 for cartons.

Comparative labor and equipment costs per ton for unloading three specified package types by this method are shown in table 17. More than 80 percent of the total cost for this operation for all package types was for labor. Bags were handled at the lowest cost, $0.53 per ton. Cartons had the highest cost, $0.64 per ton. Because this method was not

TABLE 16.--Labor and equipment required to unload 1 ton of 3 specified package types from railroad cars and place in storage in a single-story warehouse by use of pallets, semilive skids, jacks, and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open car, prepare to unload (secure 2 skids: 20 feet) | 2 | 0.009 | 0.009 | 0.019 | 0.011 | 0.011 | 0.022 | 0.011 | 0.011 | 0.022 |
| (b) Secure supply of 18 pallets (150 feet) | 1 | .002 | .004 | .002 | .002 | .004 | .002 | .002 | .005 | .002 |
| Handstack pallet: | | | | | | | | | | |
| (c) On dock | 2 | .018 | .036 | .036 | .019 | .039 | .039 | .009 | .018 | .018 |
| (d) On semilive skid in car and move to car door | 2 | .076 | .456 | .152 | .085 | .509 | .169 | .072 | [3] .288 | .144 |
| (e) Close car | 2 | .006 | .006 | .011 | .006 | .006 | .012 | .007 | .007 | .014 |
| (f) Transport load to stamping and checking (300 feet) | 1 | .032 | .064 | .032 | .029 | .058 | .029 | .031 | .062 | .031 |
| (g) Lot stamp | 1 | .029 | .029 | .029 | .036 | .036 | .036 | .015 | .015 | .015 |
| (h) Transport to storage room (300 feet) and stack | 1 | .057 | .114 | .057 | .052 | .104 | .052 | .055 | .110 | .055 |
| Total | | .229 | .718 | .338 | .240 | .767 | .361 | .202 | .516 | .301 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296, and bags, 400.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons, and bags, 20.2 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22, and bags, 23.
Packages per unit load: Cans, 54; cartons, 60, and bags, 18.
Unit load of stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 6 tiers.
Loads from dock: Cans, 4; cartons, 3, and bags, 3.
Loads from inside car: Cans, 24; cartons, 19, and bags, 20.

[2] Equipment required: Operation (a) 1 bridge plate; (b) one 3,000-pound riding-type, counterbalanced forklift truck, one 40-inch by 48-inch pallet; (c) 1 pallet, 1 bridge plate; (d) two 36-inch by 60-inch 2,500-pound semilive skids and one 3,000-pound jack, 2 pallets, 1 bridge plate; (e) 1 bridge plate; (f) 1 riding-type, counter-balanced forklift truck, 1 pallet; (g) 1 pallet; (h) 1 riding-type, counter-balanced forklift truck, 1 pallet. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

[3] One bridge plate, 1 pallet, 1 skid, and 1 jack.

TABLE 17.--Comparative labor and equipment costs for unloading 1 ton of 3 specified package types from railroad cars and placing into storage in a single-story warehouse by use of pallets, semilive skids, jacks, and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans | 0.229 | [3] 0.718 | 0.338 | 0.11 | 0.50 | 0.61 | 0.70 |
| Cartons | .240 | [4] .767 | .361 | .11 | .53 | .64 | .73 |
| Bags | .202 | [5] .516 | .301 | .09 | .44 | .53 | .62 |

[1] Transportation distances were standardized at 300 feet from railroad car to temporary storage and 300 feet from temporary storage to stacking point.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.109 machine-hour; 3,000-pound industrial forklift truck, 0.091 machine-hour; 28 (40- by 48-inch) pallets, 0.290 machine-hour; 28 semilive skids, 0.152 machine-hour; 3,000-pound skid-jack, 0.076 machine-hour; total, 0.718 machine-hour.

[4] Bridge plate, 0.121 machine-hour; 3,000-pound industrial forklift truck, 0.083 machine-hour; 22 (40- by 48-inch) pallets, 0.308 machine-hour; 22 semilive skids, 0.170 machine-hour; 3,000-pound skid-jack, 0.085 machine-hour; total, 0.767 machine-hour.

[5] Bridge plate, 0.099 machine-hour; 3,000-pound industrial forklift truck, 0.089 machine-hour; 23 (40- by 48-inch) pallets, 0.184 machine-hour; 23 semilive skids, 0.072 machine-hour; 3,000-pound skid-jack, 0.072 machine-hour; total, 0.516 machine-hour.

used for handling carcasses at any of the warehouses studied, this product was excluded from this analysis.

## COMPARISON OF SELECTED METHODS FOR UNLOADING FROM RAILROAD CARS AND PLACING INTO STORAGE IN SINGLE-STORY WAREHOUSES

Table 18 shows, for selected methods and specified containers, the labor and equipment required per ton and the labor and equipment costs per ton for unloading from railroad cars and placing into storage in a single-story warehouse. Because single-story warehouses are generally designed for use of modern materials-handling equipment, this section has been limited to two methods, both using pallets and forklift trucks. One method is supplemented by semilive skids and jacks.

Cans. --In the single-story warehouse surveyed, it was found that by placing the pallets in the door of the car and loading them in that position, there was a saving in equipment costs of $0.01 per ton, when compared to loading the pallets on semilive skids inside the car and pulling the skids with a jack to the car door. The two methods had the same labor cost; thus the increase in cost from $0.60 to $0.61 per ton was caused by the extra equipment used. It is debatable whether the additional expense involved is justified by the amount of worker fatigue eliminated; an argument may be based, however, on the fact that the small additional cost of this method may be worthwhile from the standpoint of the beneficial effect on worker morale.

Cartons. --Cartons, crates, and other cubical rigid containers were unloaded and placed into storage faster and at a lower cost when the pallets were loaded on semilive skids and pulled to the car door with a skid-jack. The labor saving amounted to $0.11 per ton. Although the use of the semilive skid and jack brought the equipment cost up somewhat, there was still a saving of $0.10 per ton in the total cost of the operation.

TABLE 18. --Comparative labor and equipment costs per ton for unloading from railroad cars and placing in storage in a single-story warehouse four types of packages by use of specified methods and types of equipment[1]

| Container and type of equipment | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time[2] | Total labor | Equipment | Labor[3] | Total cost: Current wages | Total cost: Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans: | | | | | | | |
| Pallets and industrial forklift trucks | 0.229 | 0.414 | 0.338 | 0.10 | 0.50 | 0.60 | 0.68 |
| Pallets, semilive skids, jacks, and industrial forklift trucks | .229 | .718 | .338 | .11 | .50 | .61 | .70 |
| Cartons: | | | | | | | |
| Pallets and industrial forklift trucks | .277 | .501 | .435 | .10 | .64 | .74 | .86 |
| Pallets, semilive skids, jacks, and industrial forklift trucks | .240 | .767 | .361 | .11 | .53 | .64 | .73 |
| Bags: | | | | | | | |
| Pallets and industrial forklift trucks | .186 | .340 | .271 | .09 | .40 | .49 | .57 |
| Pallets, semilive skids, jacks, and industrial forklift trucks | .202 | .516 | .301 | .09 | .44 | .53 | .61 |
| Carcasses: | | | | | | | |
| Pallets and industrial forklift trucks | .437 | .826 | .597 | .25 | .89 | 1.14 | 1.29 |

[1] Transportation distances standardized at 300 feet from railroad car to temporary storage and 300 feet from temporary storage to stacking point.
[2] For equipment time, see tables 14 and 16.
[3] Computed from "current" wage rates.

Bags. --During this study, it was observed that bags could be handled faster and with less cost without the use of semilive skids and jack. When workers loaded directly on pallets in the car door, total costs were $0.49 per ton, compared with $0.53 per ton when semilive skids and jack were used, or a saving of $0.04 per ton based on current wages.

Carcasses. --In the warehouse surveyed, semilive skids and jacks were not used in combination with pallets and an industrial truck to unload animal carcasses and place them into storage. Carcasses are the most expensive to handle of the products studied. At $1.14 per ton, the cost of handling carcasses was $0.40 higher than the highest cost method for handling cartons.

Figure 23 gives a graphic comparison of the elapsed times for the two principal methods of handling used in the single-story warehouse, for cans, cartons, bags, and carcasses. For cans, there was no difference between the two methods. In handling cartons, semilive skids and jacks speeded the operation in the railroad car. The time required to place the cartons in storage, that is, to transport from loading platform through lot stamping to the storage rooms and stack in storage, was the same for both methods. The elapsed time for the entire operation was 0.037 hour faster when skids and jacks were used. The use of semilive skids and jacks in handling bags by this method slows up the unloading and placing into storage by 0.016 hour per ton.

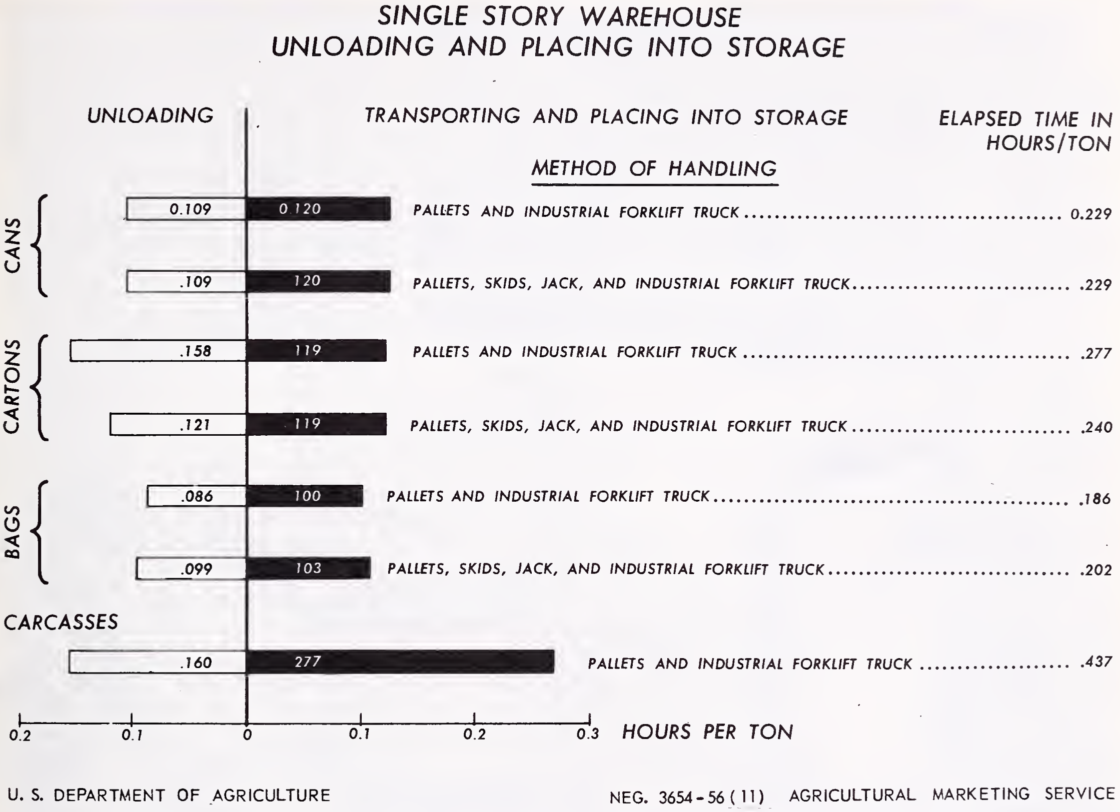


Figure 23.--Elapsed times for unloading a ton of specified package types from railroad cars and placing into storage by use of two handling methods.

No comparative figures for elapsed time for carcass handling are available at this time because the use of skids and jacks for handling carcasses was not observed during the survey.

## UNLOADING FROM HIGHWAY TRUCKS AND PLACING INTO STORAGE

Much of the merchandise received at public refrigerated warehouses arrives by highway truck. There has been a growth in this type of receipts particularly on short hauls. Since this growth appears to be continuing as insulated and refrigerated truck bodies are developed and improved, unloading from highway trucks and placing into storage is becoming a more important operation. Therefore, this operation is discussed separately from unloading from railroad cars and placing into storage.

However, a number of the elements of the two operations are identical. There are several exceptions, of course, and to these are due the chief differences in handling times.

First, loads carried by trucks are usually smaller than those carried by railroad cars, especially in the East where the overall tractor-trailer size is limited according to the laws of several of the States. This increases by a small amount, the time needed for opening the truck and rigging lights, when distributed over the total tonnage carried by the truck trailer, usually not more than 16 tons. Second, the narrow width of the truck impedes the handstacking operation, increasing the unloading time for some package types. Another disadvantage is the changing slope of the trailer bed as the trailer is unloaded. This can be a real disadvantage when unloading relatively dense merchandise that gives the trailer bed a forward slope, requiring uphill travel of the loaded hand truck. Usually two men are required to remove the hand truck from the trailer when this happens.

In all the warehouses studied, all the labor required to unload from railroad cars was supplied by the warehouse. In contrast, on the truck platforms, some of the warehouses furnished one man to help the driver unload, while in others no labor was furnished for this purpose. The cost comparisons made in this study are based upon the assumption that all the labor is supplied and paid for by the warehouse.

In the following discussion, highway trucks and trailers are called trailers, and platform hand trucks are called trucks or hand trucks. Table titles, however, use the term highway trucks.

## Multistory Warehouses

### HAND TRUCKS

The method of unloading from trailers and placing into storage by use of hand trucks was the same as the method described earlier in this report for unloading railroad cars.

Trailers were unloaded by hand-stacking the containers on hand trucks. For the first few unit loads, the hand trucks were spotted on the platform at the tail gate of the trailer and the containers usually were removed from the trailer and stacked on the hand truck (fig. 24). As space became available in the trailer, the hand trucks were pushed inside the trailer for loading. Subsequent hand trucks were loaded by spotting each truck as closely as possible to the work face inside the trailer and placing the packages on the truck. Because of the push rail at one end of the four-wheel hand truck and at both ends of the six-wheel hand truck, the trucks were turned so that the length of the truck platform was crosswise in the trailer body. When this was done, the containers did not need to be lifted over the handles. The loaded hand trucks were moved out of the trailer onto the platform, where the containers were lot stamped. The loaded hand trucks were moved to the elevator, pushed onto the elevator, and moved to the proper floor. The hand trucks were then pushed through manually operated doors into the storage rooms and spotted at the stacks. The containers were then hand-stacked to an average height of 9 feet in the storage position.

Labor and equipment requirements for this operation are shown in table 19.

Labor requirements at 1.004 man-hours per ton were highest for handling carcasses. Bags required 0.471 man-hour per ton, or less than 50 percent of that for carcasses. Cans and cartons required 0.547 man-hour and 0.584 man-hour respectively. The elapsed times reflected somewhat the same relationship, bags being received the fastest per ton and carcasses the slowest.

Table 20 summarizes the labor and equipment costs for unloading 1 ton of 4 specified package types from trailers and placing into storage by use of hand trucks. The total costs for this operation for bags was \$0.75 per ton. The costs for cans and cartons were somewhat higher. For carcasses, the costs were \$1.63 per ton, or 117 percent higher.

When speed is the prime requisite in the unloading operation, the number of workers in the unloading crew may be increased; however, because of the narrowness of the trailer body, it is undesirable to have more than two workers at work inside the trailer at the same time. Since only one hand truck can be loaded inside the trailer, the decrease in

elapsed time is very small when more than two workers are used, and the cost of unloading increases considerably.

If there is a definite upward slope of the trailer floor to the dock, two workers should be used to push the truck off the trailer onto the platform. This depends somewhat upon the load that is being removed from the trailer. Ordinarily, it is not necessary to employ two men to handle light, bulky produce; therefore, the weight of the load should be the governing factor in determining the crew size assigned to a given operation.

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Figure 24.--Loaded hand truck at tail gate of highway truck.

TABLE 19.--Labor and equipment required to unload 1 ton of 4 specified package types from highway trucks and place in storage in multistory warehouses by use of hand trucks[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | | 200-pound carcasses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open trailer, prepare to unload (secure hand truck: 20 feet) | 2 | 0.011 | 0.011 | 0.023 | 0.011 | 0.011 | 0.022 | 0.015 | 0.015 | 0.030 | 0.019 | 0.019 | 0.038 |
| Handstack, hand truck | | | | | | | | | | | | | |
| (b) On dock at tail gate | 2 | .019 | .037 | .037 | .022 | .044 | .044 | .008 | .016 | .016 | .019 | .038 | .038 |
| (c) Inside trailer body | 2 | .082 | .164 | .164 | .089 | .178 | .178 | .066 | .133 | .133 | .133 | .266 | .266 |
| (d) Close trailer | 2 | .003 | .003 | .006 | .003 | .003 | .006 | .004 | .004 | .008 | .005 | .005 | .010 |
| (e) Lot stamp, transport loads to elevator (145 feet) | 1 | .076 | .076 | .076 | .081 | .081 | .081 | .061 | .061 | .061 | .146 | .146 | .146 |
| (f) Elevator transport (48 feet) | 1 | .041 | .124 | .041 | .041 | .123 | .041 | .041 | .125 | .041 | .112 | .337 | .112 |
| (g) Transport loads to storage room (140 feet), hand stack for storage | 2 | .100 | .200 | .200 | .106 | .212 | .212 | .091 | .182 | .182 | .197 | .394 | .394 |
| Total | | .332 | .615 | .547 | .353 | .652 | .584 | .286 | .536 | .471 | .631 | 1.205 | 1.004 |

[1] Loading data:
Packages per truckload equivalent: cans, 1,000; cartons, 1,000; bags, 250; carcasses, 100.
Total gross weight of packages: Cans, 16 tons; cartons, 16 tons; bags, 12.63 tons, and carcasses, 10 tons.
Unit loads per truckload equivalent: Cans, 20; cartons, 20; bags, 16, and carcasses, 34.
Packages per unit load: Can, 51; cartons, 50; bags, 16, and carcasses, 3.
Unit load stacking: Cans, 17 by 3 tiers; cartons, 10 by 5 tiers; bags, 4 by 4 tiers, and carcasses, 3 per hand truck.
Loads from dock: Cans, 3; cartons, 3; bags, 2, and carcasses, 5.
Loads from inside car: Cans, 17; cartons, 17; bags, 14, and carcasses, 29.

[2] Equipment required: Operation (a) 1 bridge plate; (b) one 30-inch by 66-inch hand truck, 1 bridge plate; (c) 1 hand truck, 1 bridge plate; (d) 1 bridge plate; (e) 1 hand truck; (f) one 3-ton elevator, 2 hand trucks; (g) 2 hand trucks. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

TABLE 20.--Comparative labor and equipment costs for unloading 1 ton of 4 specified package types from highway trucks and placing into storage in multistory warehouses by use of hand trucks[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost: Current wages | Total cost: Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans | 0.332 | [3] 0.615 | 0.547 | 0.07 | 0.79 | 0.86 | 1.00 |
| Cartons | .353 | [4] .652 | .584 | .07 | .85 | .92 | 1.06 |
| Bags | .286 | [5] .536 | .471 | .07 | .68 | .75 | .87 |
| Carcasses | .631 | [6] 1.205 | 1.004 | .18 | 1.45 | 1.63 | 1.89 |

[1] Transportation distances were standardized at 145 feet from highway truck to elevator, 48 feet elevator transport, and 140 feet from elevator to stacking point.
[2] Computed from "current" wage rates.
[3] Bridge plate, 0.115 machine-hour; 20 hand trucks, 0.459 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.615 machine-hour.
[4] Bridge plate, 0.125 machine-hour; 20 hand trucks, 0.486 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.652 machine-hour.
[5] Bridge plate, 0.093 machine-hour; 16 hand trucks, 0.402 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.536 machine-hour.
[6] Bridge plate, 0.176 machine-hour; 34 hand trucks, 0.917 machine-hour; 3-ton elevator, 0.112 machine-hour; total, 1.205 machine-hours.

## PALLETS, SEMILIVE SKIDS, JACK, AND INDUSTRIAL FORKLIFT TRUCK

This method is similar to the handling operation described in the previous section for railroad cars.

Highway trucks and trailers were unloaded by handstacking the containers on pallets. For the first few unit loads, the pallets were placed on the platform at the tail gate of the trailer and the containers placed on them. After sufficient space was available inside the trailer body, the pallets were placed on a semilive skid and moved with a skid jack to the work face inside the trailer. The containers were manually stacked on the pallet. The pallet-loaded semilive skid was then moved to the tail gate. Loaded pallets were removed from the platform or from the semilive skid by an industrial forklift truck (fig. 25). The loaded pallets were moved to and placed in temporary storage at the work area. Here the containers were lot stamped, weighed, and checked. The pallets were then picked up by the forklift truck, transported to the storage rooms through automatically operated storage room doors, and placed in the storage position.

Table 21 shows the labor and equipment requirements for unloading and placing into storage 1 ton of 4 specified package types by this method. Bags again were handled with less labor per ton than the other container types, at 0.287 man-hour per ton. The handstacking of the containers required more than half of the labor involved. Carcasses required 0.677 man-hour. Labor required for cans and cartons was almost identical at 0.372 man-hour and 0.374 man-hour, respectively.

The elapsed time to perform this operation, when bags were handled, amounted to 0.192 hour per ton. This was the fastest time and was about one-third of the time for carcasses, which required 0.483 hour per ton.

TABLE 21. --Labor and equipment required to unload 1 ton of 4 specified package types from highway trucks and place in storage in single-story warehouse by use of pallets, semilive skids, jacks, and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | | 200-pound carcasses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Open trailer, prepare to unload (secure 2 skids: 20 feet).......... | 2 | 0.012 | 0.012 | 0.024 | 0.012 | 0.012 | 0.024 | 0.015 | 0.015 | 0.030 | 0.019 | 0.019 | 0.038 |
| (b) Secure supply of 12 pallets (150 feet). | 1 | .002 | .004 | .002 | .002 | .004 | .002 | .002 | .004 | .002 | .007 | .014 | .007 |
| Unload trailer, pallet: | | | | | | | | | | | | | |
| (c) On dock............................ | 2 | .019 | .038 | .039 | .016 | .032 | .032 | .009 | .018 | .018 | .020 | .040 | .040 |
| (d) Inside trailer on semilive skid...... | 2 | .087 | .348 | .174 | .097 | .388 | .194 | .067 | .268 | .134 | .151 | .604 | .301 |
| (e) Close trailer......................... | 2 | .003 | .003 | .006 | .003 | .003 | .006 | .004 | .004 | .008 | .005 | .005 | .010 |
| (f) Transport load to stamping and checking (300 feet)................. | 1 | .032 | .064 | .032 | .028 | .057 | .028 | .030 | .060 | .030 | .092 | .184 | .092 |
| (g) Lot stamp............................ | 1 | .037 | .037 | .037 | .036 | .036 | .036 | .014 | .014 | .014 | .023 | .023 | .023 |
| (h) Transport to storage room (300 feet) and stack.......................... | 1 | .058 | .116 | .058 | .052 | .104 | .052 | .051 | .102 | .051 | .166 | .333 | .166 |
| Total.......................... | | .250 | .622 | .372 | .246 | .636 | .374 | .192 | .485 | .287 | .483 | 1.222 | .677 |

[1] Loading data:
Packages per truckload equivalent: Cans, 1,000; cartons, 1,000; bags, 250, and carcasses, 100.
Total gross weight of packages: Cans, 16 tons; cartons, 16 tons; bags, 12.63 tons, and carcasses, 10 tons.
Unit loads per truckload equivalent: Cans, 19; cartons, 20; bags, 14, and carcasses 34.
Packages per unit load: Cans, 54; cartons, 50; bags, 18, and carcasses 3.
Unit load stacking: cans, 18 by 3 tiers; cartons, 10 by 5 tiers; bags, 3 by 6 tiers, and carcasses, 3 per pallet.
Loads from dock: Cans, 3; cartons, 3; bags, 2, and carcasses, 5.
Loads from inside car: Cans, 16; cartons, 17; bags, 12, and carcasses, 29.

[2] Equipment required: Operation (a) 1 bridge plate; (b) one 40-inch by 48-inch pallet, one 3,000-pound industrial forklift truck; (c) 1 pallet, 1 bridge plate; (d) 1 pallet, one 36-inch by 60-inch semilive skid, one 3,000-pound jack, 1 bridge plate; (e) 1 bridge plate; (f) 1 pallet, 1 industrial forklift truck; (g) 1 pallet; (h) 1 pallet, 1 industrial forklift truck. For a detailed description of the elements composing this operation, see the table of element standards in the appendix.

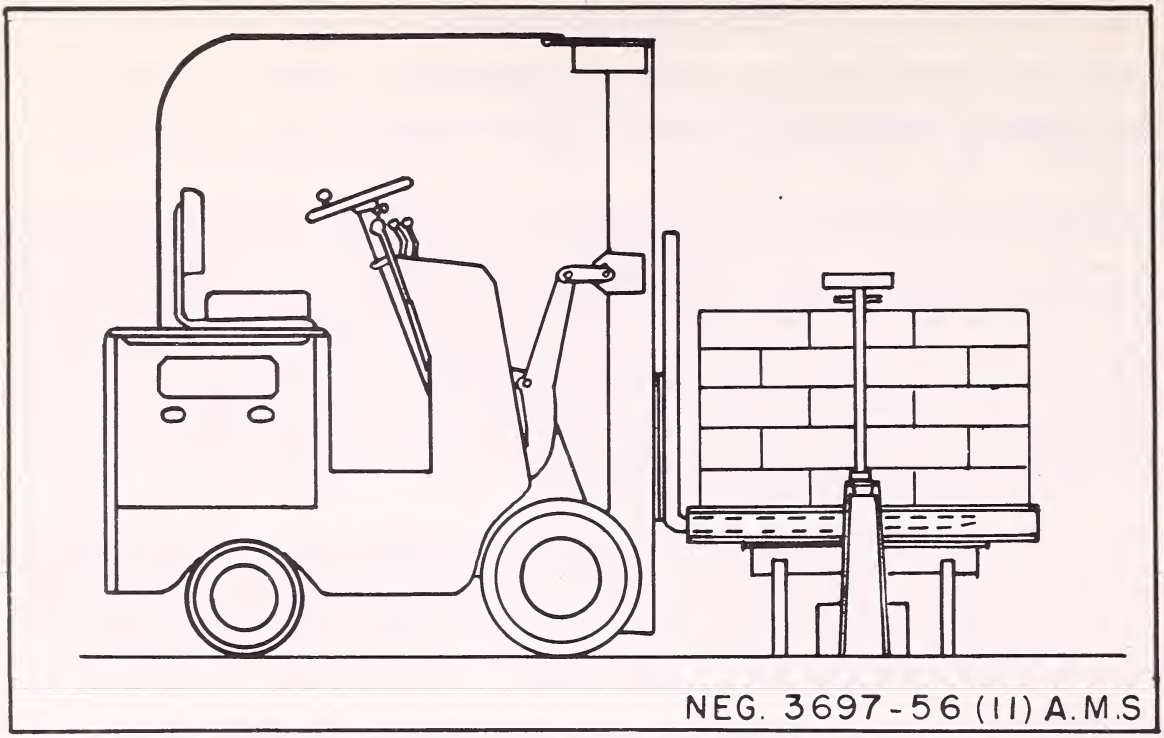


Figure 25.--Industrial forklift truck removing loaded pallet from semilive skid.

TABLE 22.--Comparative labor and equipment costs for unloading 1 ton of 4 specified package types from highway trucks and placing into storage in a single-story warehouse by the use of pallets, semilive skids, jack, and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required: Equipment time | Labor and equipment required: Total labor | Labor and equipment costs: Equipment | Labor and equipment costs: Labor[2] | Total cost: Current wages | Total cost: Assumed wages |
|---|---|---|---|---|---|---|---|
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans...... | 0.250 | [3] 0.622 | 0.372 | 0.10 | 0.55 | 0.65 | 0.74 |
| Cartons... | .246 | [4] .636 | .374 | .10 | .55 | .65 | .74 |
| Bags...... | .192 | [5] .485 | .287 | .09 | .43 | .52 | .59 |
| Carcasses. | .483 | [6] 1.222 | .677 | .26 | 1.01 | 1.27 | 1.44 |

[1] Transportation distances were standardized at 300 feet from highway truck to temporary storage and 300 feet from temporary storage to stacking point.
[2] Computed from "current" wage rates.
[3] Bridge plate, 0.121 machine-hour; 19 (40- by 48-inch) pallets, 0.235 machine-hour; 3,000-pound industrial forklift truck, 0.092 machine-hour; 19 semilive skids, 0.087 machine-hour; 3,000-pound skid jack, 0.087 machine-hour; total, 0.622 machine-hour.
[4] Bridge plate, 0.128 machine-hour; 20 (40- by 48-inch) pallets, 0.231 machine-hour; 3,000-pound industrial forklift truck, 0.083 machine-hour; 20 semilive skids, 0.097 machine-hour; 3,000-pound skid jack, 0.097 machine-hour; total, 0.636 machine-hour.
[5] Bridge plate, 0.095 machine-hour; 14 (40- by 48-inch) pallets, 0.173 machine-hour; 3,000-pound industrial forklift truck, 0.083 machine-hour; 14 semilive skids, 0.067 machine-hour; 3,000-pound skid jack, 0.067 machine-hour; total, 0.485 machine-hour.
[6] Bridge plate, 0.195 machine-hour; 34 (40- by 48-inch) pallets, 0.459 machine-hour; 3,000-pound industrial forklift truck, 0.266 machine-hour; 34 semilive skids, 0.151 machine-hour; 3,000-pound skid jack, 0.151 machine-hour; total, 1.222 machine-hours.

Labor and equipment costs for unloading four specified container types from trailers and placing into storage by using pallets, semilive skids, jack, and an industrial truck are shown in table 22. Bags were handled at the lowest cost, $0.52 per ton; cans and cartons at identical cost, $0.65; and carcasses at the highest cost, $1.27. For all package types, approximately 80 percent of the total cost was for labor.

In the warehouse in which this method was observed, it was found that two workers performed the work on the trailer most effectively. One working alone encountered considerable difficulty in pushing the loaded pallets to the tail gate, especially after the trailer had been unloaded to the point where there was an upward slope toward the open end of the trailer. If more than two workers were employed at this point of operation, the cost per ton was increased considerably because of interference between workers inside the narrow trailer body, and the elapsed time was not reduced appreciably.

## COMPARISON OF COSTS OF UNLOADING SELECTED COMMODITIES FROM RAILROAD CARS AND HIGHWAY TRUCKS AND PLACING IN STORAGE IN MULTISTORY AND SINGLE-STORY WAREHOUSES

In general, the operation involving the receipt and storage of commodities in the multistory warehouses was performed more efficiently and more economically when shipments were received by railroad car than by highway truck. This economy in labor and equipment resulted from two factors: (1) The railroad car opening time was distributed over approximately 50 percent greater tonnage, because there were 24 tons in a carload of cans as against 16 tons in a highway truck; and (2) handling was somewhat easier in the larger space within the railroad car.

In following sections, the reader may compare the cost of unloading from both railroad cars and highway trucks and placing in storage in multistory and single-story warehouses. The costs included in table 23 are based on direct labor and equipment costs only, and do not include managerial costs, costs of land or buildings, or refrigeration.

### Multistory Warehouses

The elevator is the most expensive piece of equipment used in the multistory warehouse. In the appendix the cost of ownership and operation is given in detail. For the purpose of the following discussion, the cost per hour of operating an elevator with a 3-ton capacity is taken as $1.53. On the basis of the same straight-line depreciation method used to compute elevator costs, an industrial forklift truck costs $0.72 per hour of use.

The elevator transportation distance was standardized at 48 feet, or 4 floors, at a cost of approximately 6 cents a round trip with an elevator speed of 100 feet per minute. Other transportation distances that were standardized for cost-comparison purposes include the distance of 20 feet required to secure an empty hand truck, the round-trip distance of 145 feet from the carrier to the elevator, and the round-trip distance of 140 feet from the elevator to the stacking point in the storage room.

The use of pallets on hand trucks, and an industrial forklift truck for stacking only, provided the least expensive method of unloading from railroad cars and placing 1 ton of cans or cartons into storage. This cost was $0.75 per ton for cans and $0.77 per ton for cartons.

The next lowest cost was in using a walkie-type, high-lift fork truck for stacking instead of the industrial forklift truck used in the method just described. Cans and cartons were unloaded and placed into storage at a cost only 2 cents per ton higher than by the first method described.

TABLE 23.--Comparative labor and equipment costs per ton for unloading four specified package types from railroad cars and highway trucks and placing into storage in multistory and single-story warehouses by use of specified methods[1]

| Type of package, warehouse, and method | Elapsed time per ton | Labor and equipment required per ton | | Labor and equipment costs per ton | | | |
|---|---|---|---|---|---|---|---|
| | | | | Equipment | Labor | Total cost | |
| | | Equipment time | Total labor | | | Current wages | Assumed wages |
| Cans: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Hand trucks | 0.320 | 0.664 | 0.524 | 0.07 | 0.76 | 0.83 | 0.96 |
| Pallets, hand trucks, industrial forklift truck | .292 | .950 | .422 | .14 | .61 | .75 | .86 |
| Pallets, hand trucks, walkie-type industrial highlift truck | .301 | .979 | .441 | .13 | .64 | .77 | .88 |
| Hand truck and walkie-type electric tractor | .333 | .735 | .536 | .08 | .78 | .86 | .99 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .332 | .615 | .547 | .07 | .79 | .86 | 1.00 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .229 | .414 | .338 | .10 | .50 | .60 | .68 |
| Pallets, semilive skids, jack, and industrial forklift truck | .229 | .718 | .338 | .11 | .50 | .61 | .70 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .250 | .622 | .372 | .10 | .55 | .65 | .74 |
| Cartons: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Hand trucks | .344 | .714 | .566 | .07 | .82 | .89 | 1.03 |
| Pallets, hand trucks, industrial forklift truck | .297 | .974 | .438 | .13 | .64 | .77 | .88 |
| Pallets, hand trucks, walkie-type industrial highlift truck | .306 | .998 | .455 | .13 | .66 | .79 | .90 |
| Hand truck and walkie-type electric tractor | .357 | .784 | .578 | .08 | .84 | .92 | .106 |
| Hand truck and gravity roller conveyor | .355 | .769 | .587 | .07 | .85 | .92 | 1.07 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .353 | .652 | .584 | .07 | .85 | .92 | 1.06 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .277 | .501 | .435 | .10 | .64 | .74 | .86 |
| Pallets, semilive skids, jack, and industrial forklift truck | .240 | .767 | .361 | .11 | .53 | .64 | .73 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .246 | .636 | .374 | .10 | .55 | .65 | .74 |
| Bags: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Hand trucks | .273 | .510 | .445 | .07 | .65 | .72 | .83 |
| Pallets, hand trucks, industrial forklift truck | .292 | .806 | .416 | .14 | .61 | .75 | .85 |
| Pallets, hand trucks, walkie-type industrial highlift truck | .304 | .842 | .440 | .13 | .64 | .77 | .88 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .286 | .536 | .471 | .07 | .68 | .75 | .87 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .186 | .340 | .271 | .09 | .40 | .49 | .57 |
| Pallets, semilive skids, jack, and industrial forklift truck | .202 | .516 | .301 | .09 | .44 | .53 | .62 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .192 | .485 | .287 | .09 | .43 | .52 | .59 |
| Carcasses: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Hand trucks | .614 | 1.172 | .975 | .18 | 1.41 | 1.59 | 1.84 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .631 | 1.205 | 1.004 | .18 | 1.45 | 1.63 | 1.89 |
| Single story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .437 | .826 | .597 | .25 | .89 | 1.14 | 1.29 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .483 | 1.222 | .677 | .26 | 1.01 | 1.27 | 1.44 |

[1] Transportation distances were standardized at 145 feet from railroad car or highway truck to elevator, 48 feet elevator transport, and 140 feet from elevator to stacking point for multistory warehouses. In single-story warehouses, transportation distances were standardized at 300 feet from railroad car or highway truck to temporary storage and lot stamp and 300 feet from temporary storage to stacking point in the cold storage rooms. These data do not include the cost of management or facilities; for example, cost of the land, building, engine room, or other overhead costs.

## Single-Story Warehouse

On the basis of handling costs alone, the single-story warehouse was considerably more efficient in its use of manpower than the multistory warehouses observed in this study, even with round-trip transportation distances increased over multistory warehouse operations and standardized at 300 feet one way from railroad car or highway truck to temporary storage, and 300 feet one way from temporary storage to the stacking point in the cold storage rooms.

Use of the industrial forklift truck for transportation and stacking in storage, together with skids and jacks or pallet dollies, made the cost for unloading cans from railroad cars and placing them into storage $0.61 per ton, cartons $0.64, bags $0.53, and carcasses $1.14 without skids or pallet dollies and $1.27 when skids were used. This operation was decidedly less expensive than the most efficient multistory warehouse operation.

## Comparison of Costs by Package Type

In table 23, the costs of handling the four specified package types are compared by type of carrier, by warehouse, and by the time required to unload and place the packages into storage.

Cans. --The most efficient method of handling cans, based on the elapsed time of 0.229 hour per ton, was in unloading railroad cars and placing into storage in the single-story warehouse by means of pallets and a riding-type, counterbalanced forklift truck. Loading the cans on pallets which were placed on semilive skids and pulling them to the car door where a forklift truck could pick them up did not change the elapsed time at all, although it cost $0.01 more, or a total cost of $0.61 per ton to use the skid. In the multistory warehouses, the best elapsed time was 0.292 hour per ton when the cans were placed on pallets carried on a hand truck and then were stacked in storage by means of an industrial forklift truck.

Total costs, based on current wages, were lowest for the two methods described above, in the same order; that is, $0.60 per ton in the single-story warehouse and $0.75 per ton in the multistory warehouse, or 20 percent less in the single-story warehouse than in the multistory.

On the basis of handling costs, which exclude the costs of management, plant structure, and maintenance, the most expensive single-story handling method (unloading a highway trailer and placing into storage by use of pallets, skids, jacks, and a forklift truck) was still $0.10 per ton less (13 percent less) than the best that could be done in a multistory warehouse ($0.75 per ton using pallets on hand trucks, and stacking by means of a riding-type counterbalanced forklift truck).

Cartons. --The quickest and the least expensive method of unloading cartons and placing them into storage from railroad car shipment was observed in the single-story warehouse when the cartons were placed on semilive skids pulled to the car door with a jack and then transported and stacked with an industrial forklift truck. Elapsed time for this method was 0.240 hour per ton. The next best time was for the same method, also used in a single-story warehouse, when shipments arrived by highway truck.

The best time observed in multistory warehouses, 0.297 elapsed hour per ton, was when cartons were piled on pallets placed on hand trucks, transported to storage rooms on hand trucks, and then stacked for storage by an industrial forklift truck.

In terms of the lowest total cost, the first of the methods just described cost $0.64 per ton for handling cartons. This was $0.13 per ton less (17 percent less) than the best multistory warehouse handling cost of $0.77. When truck shipments were handled in a single-story warehouse in the manner described as the fastest method, the elapsed time of 0.246 hour per ton was only 2.5 percent more, or $0.01 more in terms of total cost, based on current wages, and it was better by $0.12 per ton, or 16 percent, than the best multistory warehouse method described above.

Bags. --The elapsed time of 0.186 hour per ton was obtained by using pallets and an industrial forklift truck in a single-story warehouse when unloading and placing bags into storage from railroad cars. This was the lowest time observed for the four general types of packages studied. This elapsed time was 32 percent less than the fastest elapsed time observed in a multistory warehouse for any method of unloading and placing into storage. The use of hand trucks alone gave the fastest elapsed time in a multistory warehouse, together with least total cost. Even the slowest time observed for the single-story operation was 26 percent less than the fastest multistory warehouse method observed during the study.

On the basis of current wages, the fastest operation using pallets and an industrial forklift truck in a single-story warehouse gave the lowest cost, $0.49 per ton of bags

handled. This was 32 percent more economical than the $0.72 required for the fastest multistory operation (hand trucks only) used in handling bags.

Carcasses.--Both railroad car and highway truck shipments of animal carcasses were unloaded and placed into storage more quickly in a single-story warehouse than in a multistory warehouse at the six warehouses observed. The unloading and placing into storage of animal carcasses is more expensive and more time-consuming than the handling of containers.[7]

The lowest elapsed time observed was 0.437 hour per ton of carcasses for a railroad car shipment received by the single-story warehouse, when the handling system made use of pallets transported and stacked by an industrial forklift truck. This is 29 percent faster and more economical than the hand truck method used in multistory warehouses.

## INTRAPLANT HANDLING

In practically all public refrigerated warehouses, a lot of merchandise placed in storage usually is not withdrawn all at one time. A firm may put 20 tons of merchandise in storage and withdraw from storage by the hundredweight over a period of a year or more. This practice results in what is known in the trade as "honeycombing."

Honeycombing is a storage practice of withdrawing containers in such a manner that empty space resulting from these withdrawals of containers is not usable.

Actually, intraplant handling is performed usually to consolidate broken lots of containers or pallet loads into a smaller space in order to provide storage for new lots and eliminate lost space caused by honeycombing. For purposes of analysis, the transfer of broken lots is assumed to take place inside the storage room in which the lots were originally warehoused. The three methods described in this section are those most commonly used by warehousemen and are generally considered the most effective from a practical standpoint. The three different methods of performing this operation are: (1) Hand stacking the packages from broken lots on a hand truck, transporting to the new location, and hand stacking the packages in a new pile; (2) hand stacking the packages from broken lots on a pallet, transporting the loaded pallet with a forklift truck to the new storage point, and positioning the loaded pallet; and (3) hand stacking the packages from broken lots on a pallet, transporting the loaded pallet with a walkie-type industrial high-lift truck to the stacking point, and positioning the loaded pallet.

Since this analysis assumes that the operation will take place within the same room, there is no need to differentiate between single-story and multistory operations.

For all methods described, the transportation distance has been assumed to be 100 feet from the old stacking point to the new. This handling operation is a relatively simple one and many warehouse operators try to do this rewarehousing when labor is not needed elsewhere. However, the operation is necessary when warehouse storage approaches capacity, and a decision not to rewarehouse would result in loss of revenue-producing space.

During this study, a check was made with the warehouse operators of the amount of merchandise normally rewarehoused. It was determined that about 10 percent of the volume received was usually handled intraplant to consolidate broken lots. Therefore, in this report, where costs are determined for each ton handled in and out of storage, it will be assumed that one-tenth of a ton was rewarehoused.

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[7] Animal carcasses, or simply "carcasses," were classified as a package type in the introduction to this report, in order to simplify the tabular presentations and the discussions concerning this commodity.

## Hand Trucks

The method using 4-wheel hand trucks was generally confined to multistory warehouses.

In this method, an empty 4-wheel hand truck was placed at the stack in the storage room. The individual containers were handstacked on the platform of the truck by a two-man crew, and the loaded hand truck was then pushed approximately 100 feet to the new stacking point, where the containers were handstacked in the new pile. The empty hand truck was then returned to the old location to be reloaded. The operation began with placing the empty hand truck at the old stack and ended with the arrival of the empty truck at the old stack for reloading.

The labor and equipment requirements for rewarehousing 1 ton of 4 selected package types are shown in table 24. Cans were handled with the least amount of labor, followed by bags and cartons. Carcasses required twice as much labor as cans in this operation. Bags were rewarehoused in the shortest period, 0.17 hour per ton.

Table 24 also shows the labor and equipment costs per ton for performing intraplant movement of containers. Most of the cost was for labor, and little for equipment. Cans were handled in this operation at a cost of $0.40 per ton, while carcasses cost more than twice as much to handle. Cartons and bags were handled for about the same cost, $0.50 per ton.

It was observed in the selected warehouses that there was little or no crew interference when the work force was increased in the storage rooms for this operation. Thus, the operation can be speeded up by increasing the work force and little loss in efficiency will result.

The costs of performing this operation can be held to a minimum by making up hand-truck loads with as many containers as possible.

Orderly withdrawal from storage and restacking of broken lots can be accomplished with greater efficiency if a standard procedure is followed. Packages in particular lots should be removed in such a way that little space is lost.

Figure 26 illustrates a right and a wrong way of withdrawing containers from storage, in order to prevent honeycombing. Honeycombing wastes valuable storage space, inasmuch as the space resulting from withdrawals is not usable for new lots. The best practice is to withdraw the containers from a lot from front to back, one row at a time. If the containers are worked off the entire front face of the lot, none of the space is usable until the entire lot is withdrawn.

## Pallets and Industrial Forklift Truck

Pallets and an industrial forklift truck can be used equally well in either single-story or multistory warehouses.

One worker drove the forklift truck to the old storage point, picked up a loaded pallet from the old stack, transported it approximately 100 feet to the new location, and placed it in the new location. In this phase of the study, only the movement of full pallet loads was analyzed.

Labor and equipment requirements and costs for transporting 1 ton of 4 specified package types in broken lots intraplant and placing them in storage in a new location by use of pallets and an industrial forklift truck are shown in table 25. Cans and cartons were handled in this operation with equal amounts of labor. Bags required less labor per ton, while carcasses required considerably more.

Bags were handled at the lowest cost, $0.08 per ton; costs for cans were somewhat higher, $0.09; and carcasses, $0.23.

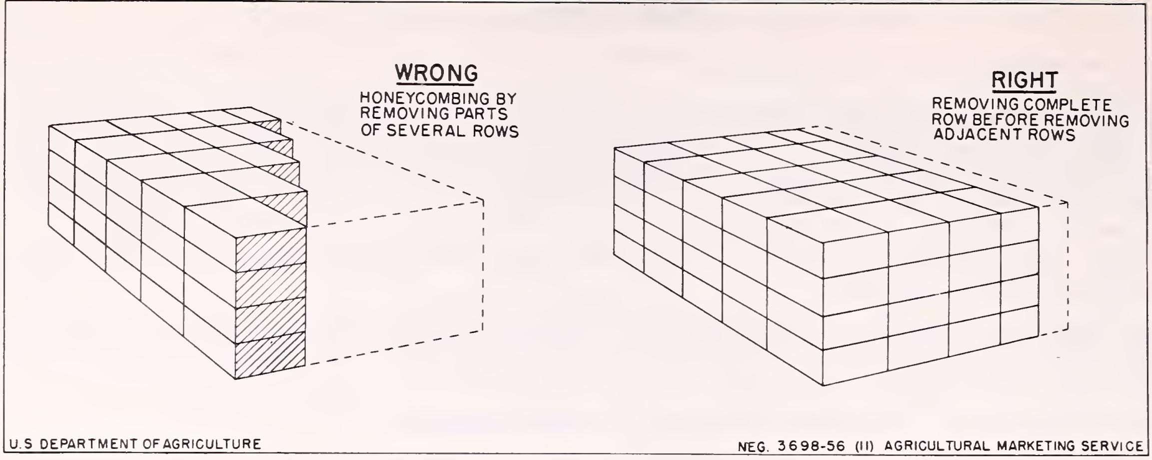


Figure 26.--A wrong and right way of withdrawing warehoused goods.

## Pallets and a Walkie-Type Industrial High-Lift Truck

The method using pallets and a walkie-type industrial truck also can be used in either single-story or multistory warehouses with equally good results.

This methodwas similar to that described just previously, except that a walkie-type industrial high-lift truck was substituted for the industrial forklift truck. The labor and equipment requirements and costs are shown in table 26, which indicates that cartons, on a ton basis, were handled with the least labor. Figures were not included for carcasses because there were no observations of this commodity being rewarehoused by this method.

Cartons were handled at the lowest cost per ton by this method (table 26). Cans were handled at about 30 percent greater cost, and bags at 55 percent greater cost than cartons.

## Comparison of Selected Methods for Performing Intraplant Handling Operations

Design of the warehouse is an important factor in determining the materials-handling method to be used. The materials-handling method, in turn, to a large extent, may determine the cost of the handling operation. These facts are demonstrated in table 27. However, the best method of materials handling observed in this study may not be the best method for specific application, because other factors besides the method and equipment used must be considered. Thus, in multistory warehouses, it is often impossible to use forklift trucks because the elevators may not be large enough, or may not have sufficient lifting capacity to move a forklift truck between floors. Or ceiling heights, door widths, column spacing, or other dimensional factors may not be proper for the handling method which gives the greatest cost advantage in another warehouse. Table 27 shows, in addition, that the best handling method for one type of container may not be the most economical method for another. For example, pallets and an industrial forklift truck provided the most economical intraplant handling of cans, bags, and carcasses; while pallets and a walkie-type industrial high-lift truck gave the best means of handling cartons.

The difference in costs between one method and another in intraplant handling is so small for some container types that the selection of a method depends on the tonnage handled, the distances through which merchandise is transported, and the supply of labor available for the handling operation. Thus, if extremely large tonnages are handled, the difference of a few cents a ton would be a factor to be considered in selecting a particular combination of handling equipment. Since handling equipment in refrigerated warehouses is selected primarily for unloading and placing into storage and for removing

**TABLE 24.--Comparative labor and equipment costs for transporting 1 ton of 4 specified package types from broken lots intraplant and placing them in storage in new locations by means of hand trucks[1]**

| Type of package | Workers | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Equipment time[2] | Total labor | Equipment | Labor[3] | Total cost | |
| | | | | | | | Current wages | Assumed wages |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans | 1 | 0.30 | 0.30 | 0.30 | 0.002 | 0.40 | 0.402 | 0.502 |
| Cartons | 1 | .37 | .37 | .37 | .002 | .50 | .502 | .602 |
| Bags | 2 | .17 | .17 | .34 | .001 | .50 | .501 | .601 |
| Carcasses | 2 | .30 | .30 | .60 | .002 | .90 | .902 | 1.002 |

[1] Loading data:
Packages per unit load: Cans, 51; cartons, 50; bags, 16, and carcasses, 3. Unit load stacking: Cans, 17 by 3 tiers; cartons, 10 by 5 tiers; bags, 4 by 4 tiers, and carcasses, 3 per hand truck.
[2] Hand trucks only. Transportation distances standardized at 100 feet from old stack to new location and return 100 feet to old stack.
[3] Computed from "current" wages.

**TABLE 25.--Comparative labor and equipment costs for transporting 1 ton of 4 specified package types in broken lots intraplant and placing them in storage in new locations by use of pallets and an industrial forklift truck[1]**

| Type of package | Workers | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Equipment time[2] | Total labor | Equipment | Labor[3] | Total cost | |
| | | | | | | | Current wages | Assumed wages |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans | 1 | 0.04 | [4] 0.08 | 0.04 | 0.034 | 0.06 | 0.09 | 0.10 |
| Cartons | 1 | .04 | [5] .08 | .04 | .034 | .06 | .09 | .10 |
| Bags | 2 | .03 | [6] .06 | .03 | .026 | .05 | .08 | .09 |
| Carcasses | 2 | .09 | [7] .18 | .09 | .078 | .15 | .23 | .25 |

[1] Loading data:
Packages per unit load: Cans, 54; cartons, 60; bags, 18, and carcasses, 3. Unit load stacking: cans, 18 by 3 tiers; cartons, 12 by 5 tiers; bags, 3 by 6 tiers, and carcasses, 3 per pallet.
[2] Transportation distances standardized at 100 feet from old stack location to new stack location and return 100 feet to old stack.
[3] Computed from "current" wages.
[4] 3,000-pound industrial forklift truck, 0.04 machine-hour; 1.4 (40-by 48-inch) pallets, 0.04 machine-hour; total, 0.08 machine-hour.
[5] 3,000-pound industrial forklift truck, 0.04 machine-hour; 1.4 (40-by 48-inch) pallets, 0.04 machine-hour; total, 0.08 machine-hour.
[6] 3,000-pound industrial forklift truck, 0.03 machine-hour; 1.1 (40-by 48-inch) pallets, 0.03 machine-hour; total, 0.06 machine-hour.
[7] 3,000-pound industrial forklift truck, 0.09 machine-hour; 3.0 (40-by 48-inch) pallets, 0.09 machine-hour; total, 0.18 machine-hour.

**TABLE 26.--Comparative labor and equipment costs for transporting 1 ton of 4 specified package types in broken lots intraplant and placing then in storage in new locations by use of pallets and a walkie-type industrial high-lift truck[1]**

| Type of package | Workers | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Equipment time[2] | Total labor | Equipment | Labor[3] | Total cost | |
| | | | | | | | Current wages | Assumed wages |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans | 1 | 0.05 | [4] 0.10 | 0.05 | 0.025 | 0.077 | 0.10 | 0.12 |
| Cartons | 1 | .04 | [5] .08 | .04 | .019 | .059 | .08 | .09 |
| Bags | 2 | .06 | [6] .12 | .06 | .030 | .092 | .12 | .14 |

[1] Loading data:
Packages per unit load: Cans, 54; cartons, 60, and bags, 18.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 6 tiers.
[2] Transportation distances standardized at 100 feet from old stack location to new, and return 100 feet to old stack.
[3] Computed from "current" wages.
[4] 3,000-pound walkie-type industrial high-lift truck, 0.05 machine-hour; 1.4 (40 by 48- inch) pallets, 0.05 machine-hour; total, 0.10 machine-hour.
[5] 3,000-pound walkie-type industrial high-lift truck, 0.04 machine-hour; 1.1 (40 by 48-inch) pallets, 0.04 machine-hour; total, 0.08 machine-hour.
[6] 3,000-Pound walkie-type industrial high-lift truck, 0.06 machine-hour; 1.1 (40 by 48-inch) pallets, 0.06 machine-hour; total, 0.12 machine-hour.

from storage and placing into railroad cars and highway trucks, intraplant handling equipment, in most instances, is dependent on the equipment selected for these major handling jobs, and not for intraplant handling alone.

Where distances between stacking locations are not great, there is little cost difference between the riding-type, and the walkie-type forklift truck. Therefore, other factors should be considered when determining which piece of equipment to use in a particular plant. However, there is a great deal of difference between hand truck and forklift truck handling. This difference varied from 30 to 67 cents a ton more for hand trucks in the warehouses surveyed. When the cost of hand-truck handling is from 3 to 4 times as much

TABLE 27.--Comparative labor and equipment costs for transporting 1 ton of 4 specified package types in broken lots intraplant and placing them in storage in new locations by 3 specified methods[1]

| Type of package and method used | Elapsed time | Labor and equipment required: Equipment time[2] | Labor and equipment required: Total labor | Labor and equipment costs: Equipment | Labor and equipment costs: Labor[3] | Total cost: Current wages | Total cost: Assumed wages |
|---|---|---|---|---|---|---|---|
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans: | | | | | | | |
| Hand trucks only | 0.30 | 0.30 | 0.30 | 0.002 | 0.40 | 0.40 | 0.50 |
| Pallets and an industrial forklift truck | .04 | .08 | .04 | .034 | .06 | .09 | .10 |
| Pallets and a walkie-type industrial high-lift truck | .05 | .10 | .05 | .025 | .08 | .10 | .12 |
| Cartons: | | | | | | | |
| Hand trucks only | .37 | .37 | .37 | .002 | .50 | .50 | .60 |
| Pallets and an industrial forklift truck | .04 | .08 | .04 | .034 | .06 | .09 | .10 |
| Pallets and a walkie-type industrial high-lift truck | .04 | .08 | .04 | .019 | .06 | .08 | .09 |
| Bags: | | | | | | | |
| Hand trucks only | .17 | .17 | .34 | .001 | .50 | .50 | .60 |
| Pallets and an industrial forklift truck | .03 | .06 | .03 | .026 | .05 | .08 | .09 |
| Pallets and a walkie-type industrial high-lift truck | .06 | .12 | .06 | .030 | .09 | .12 | .14 |
| Carcasses: | | | | | | | |
| Hand trucks only | .30 | .30 | .60 | .002 | .90 | .90 | 1.00 |
| Pallets and an industrial forklift truck | .09 | .18 | .09 | .078 | .15 | .23 | .25 |

[1] Transportation distances standardized at 100 feet from old stack location to new, and return 100 feet to the old stack.
[2] For equipment time, see tables 24, 25, and 26.
[3] Computed from "current" wage rates.

as forklift truck handling, the warehousemen should take stock of the situation. If he cannot use forklift trucks in his storage rooms, he is at a disadvantage, for then, he must seek other means of reducing costs. There is, also, the question of space utilization; it may be more economical to use hand trucks and handstacking methods where low ceiling heights are encountered, thus obtaining greater space utilization, than to use forklift trucks where 7-foot to 12-foot aisles are necessary.

## REMOVING FROM STORAGE AND LOADING INTO RAILROAD CARS

Most of the public refrigerated warehouses in this country load some commodities into refrigerated cars for shipment after the commodities have been held for storage. Much of the merchandise which moves out to railroad cars has been stored "in-transit." That is, shippers stop a railroad car at a public refrigerated warehouse having in-transit storage privileges, unload the contents of the car into storage, hold them there for a storage period, then load them into a railroad car, and move them to the final destination. Shippers are charged only the through rate on the contents of the car, rather than the combined rate from the original shipping point to the stop-over point and from the stop-over point to the final destination. Other merchandise may originate in the area of the warehouse and be held there for freezing, curing, or other conditioning, and then be loaded into railroad cars for transportation to another storage point or to a consuming area.

Removing products from storage and loading into railroad cars includes breaking commodities out of stacks, either in unit loads or by the piece; loading the packages on the handling equipment; transporting to the elevator; transport by elevator; transporting from elevator to loading platform; opening railroad car in preparing to load; handstacking packages inside car; and closing door. Where industrial equipment is used or the operations take place in a single-story warehouse, some variations from that procedure may be required. The process is the reverse of unloading from railroad cars and placing into storage. Because there were differences in this operation as it was performed in multistory and single-story warehouses, a separate analysis was made by type of warehouse.

### Multistory Warehouses

#### HAND TRUCKS

In this operation, an empty hand truck was taken to the storage point, and the containers were manually removed from the storage-room stacks and handstacked on the

hand truck (fig. 27). The loaded hand trucks were transported through manually operated storage room doors to the elevators and placed on the elevators. They then were carried to the loading platform floor. The hand trucks were moved to the loading platform. As needed, the trucks were moved into the railroad car and spotted at the work face inside the car. The containers were then removed from the hand truck and handstacked in the car. When the car was loaded to the point where it was no longer possible to push the loads into the car, the hand trucks were spotted on the platform at the car door, and the loading of the car was completed.

Table 28 shows labor and equipment requirements to move 1 ton of 4 specified types of containers from storage and load them into a railroad car with hand trucks.

Bags at 0.390 man-hour per ton required the least labor of the 4 package types analyzed. Cans required 0.420 man-hour and cartons, 0.449 man-hour. Carcasses showed the highest labor requirement at 0.935 man-hour a ton, over twice the labor needed for bags. The elapsed times for the 4 package types followed the same pattern as the labor required; that is, bags were handled fastest on a ton basis while carcasses were slowest.

Table 29 shows that bags were handled for $0.63 per ton, cans for $0.68, cartons for $0.72, and carcasses for $1.54. Using bag-handling costs as a base, it cost 8 percent more to handle cans, 14 percent more to handle cartons, and 144 percent more to handle carcasses, when hand trucks alone were used.

If speed is the prime requisite in loading cars, the number of workers in the loading crews can be increased, especially when two hand trucks can be placed in the cars at the same time.

The speed of "breaking stack," or removing the containers from the storage room, depends upon the width of the stack face and the number of lots to be withdrawn. If the width of the stack will permit, a number of hand trucks can be loaded simultaneously to increase the speed of this operation. As far as possible, the workers should avoid honeycombing the remaining lot or lots. If withdrawals are accomplished systematically, space utilization can be maximized.

TABLE 28.--Labor and equipment required to move 1 ton of 4 specified package types out of storage and load into railroad cars by use of hand trucks[1]

| Operation element[2] | Workers | 32-pound cans[3] | | | 32-pound carton[3] | | | 101-pound bags[3] | | | 200-pound carcasses[3] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to elevator (140 feet) | 2 | 0.102 | 0.203 | 0.203 | 0.109 | 0.218 | 0.218 | 0.088 | 0.176 | 0.176 | 0.200 | 0.400 | 0.400 |
| (b) Elevator transport (48 feet) | 1 | .041 | .123 | .041 | .041 | .123 | .041 | .041 | .123 | .041 | .110 | .330 | .110 |
| (c) Transport load, elevator to loading dock (145 feet) | 1 | .036 | .036 | .036 | .037 | .037 | .037 | .035 | .035 | .035 | .096 | .096 | .096 |
| (d) Open car, prepare to load | 2 | .009 | .009 | .018 | .011 | .011 | .021 | .011 | .011 | .022 | .015 | .015 | .029 |
| Handstack, hand truck: | | | | | | | | | | | | | |
| (e) At work face inside car | 2 | .045 | .135 | .090 | .051 | .153 | .102 | .046 | [4] .092 | .092 | .126 | [4] .252 | .252 |
| (f) On platform at car door | 2 | .010 | .020 | .020 | .009 | .018 | .018 | .005 | .010 | .010 | .015 | .030 | .030 |
| (g) Close car | 2 | .006 | .006 | .012 | .006 | .006 | .012 | .007 | .007 | .014 | .009 | .009 | .018 |
| Total | | .249 | .532 | .420 | .264 | .566 | .449 | .233 | .454 | .390 | .571 | 1.132 | .935 |

[1] In the warehouses in this study, only a small amount of dunnage was placed in cars during the loading operation. This was because the distance from storage to destination was short, thus heavy blocking was unnecessary. The cost of loading cars, therefore, does not include the cost of heavy blocking which might be required on special occasions.

Equipment required: Operation (a) two 30-inch by 66-inch hand trucks; (b) 2 hand trucks, one 3-ton elevator; (c) 1 hand truck; (d) 1 bridge plate; (e) 2 hand trucks, 1 bridge plate; (f) 1 hand truck, 1 bridge plate; (g) 1 bridge plate. For a detailed description of the elements composing this operation, see table of element standards in the appendix.

[3] Loading data:

Packages per carload equivalent: Cans, 1,500; cartons, 1,296; bags, 400, and carcasses, 150. Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons; bags, 20.2 tons, and carcasses, 15 tons. Unit loads per carload equivalent: Cans, 30; cartons, 26; bags, 25, and carcasses, 50. Packages per unit load: Cans, 51; cartons, 50; bags, 16, and carcasses, 3. Unit load stacking: Cans, 17 by 3 tiers; cartons, 10 by 5 tiers; bags, 4 by 4 tiers, and carcasses, per hand truck. Loads stacked inside car: Cans, 26; cartons, 23; bags, 22, and carcasses, 44. Loads stacked from dock: Cans, 4; cartons, 3; bags, 3, and carcasses, 6.

One bridge plate and 1 hand truck.

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Figure 27.--Breaking a stack in a storage room and loading a hand truck.

TABLE 29.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage and loading into railroad cars by use of hand trucks[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.249 | [3] 0.532 | 0.420 | 0.07 | 0.61 | 0.68 | 0.78 |
| Cartons.... | .264 | [4] .566 | .449 | .07 | .65 | .72 | .83 |
| Bags....... | .233 | [5] .454 | .390 | .07 | .56 | .63 | .73 |
| Carcasses.. | .571 | [6] 1.132 | .935 | .18 | 1.36 | 1.54 | 1.77 |

[1] Transportation distances standardized at 140 feet from storage point to elevator, 48 feet elevator travel and 145 feet from elevator to railroad car.
[2] Computed from "current" wage rates.
[3] Bridge plate, 0.070 machine-hour; 30 hand trucks, 0.421 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.532 machine-hour.
[4] Bridge plate, 0.077 machine-hour; 26 hand trucks, 0.448 machine-hour; 3-ton elevator, 0.041 machine-hour; total, 0.566 machine-hour.
[5] Bridge plate, 0.069 machine-hour; 25 hand trucks, 0.344 machine-hour; 3-ton elevator, 0.041 machine-hour; total 0.454 machine-hour.
[6] Bridge plate, 0.165 machine-hour; 50 hand trucks, 0.857 machine-hour; 3-ton elevator, 0.110 machine-hour; total, 1.132 machine-hours.

Elevator transportation can be accelerated by placing additional workers on the elevator to help the operator push loads on and off. This was done in some warehouses where the elevator platforms were large enough to accommodate 4 or more hand trucks at a time. However, it is generally true that extra workers on the elevator increased the total cost of handling beyond justification.

To speed the loading operation, enough hand trucks should be available so workers do not need to wait for additional trucks.

In assigning workers, care should be taken to avoid crew sizes which cause interference between workers. This is especially important when the railroad cars are being loaded from hand trucks spotted on the platform.

## PALLETS, HAND TRUCKS, AND AN INDUSTRIAL FORKLIFT TRUCK

The pallet loads were removed from the stacks in the storage room and placed on hand trucks with an industrial forklift truck. A two-man crew was used, and one man positioned the hand truck while the forklift truck operator placed the pallet load on the hand truck. The loaded hand trucks were then transported to the elevators through manually operated storage room doors. The hand trucks were pushed onto the elevator, transported to the platform floor, moved into the railroad car, and spotted at the work face. The containers were manually removed from the pallet and stacked in the car. When the car had been loaded to the point where it was no longer possible to push the loads into the car, the hand trucks were spotted on the platform as closely as possible to the car door. The remaining containers were removed from the hand truck and stacked in the cars.

The labor and equipment requirements to move 1 ton of 3 selected container types out of storage and load the commodities into railroad cars are shown in table 30.

TABLE 30. --Labor and equipment required to move 1 ton of 3 specified package types out of storage and load into railroad cars by use of pallets, hand trucks, and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack | 2 | 0.019 | 0.056 | 0.038 | 0.017 | 0.052 | 0.034 | 0.020 | 0.060 | 0.040 |
| (b) Transport to elevator (140 feet) | 1 | .052 | .104 | .052 | .047 | .094 | .047 | .059 | .118 | .059 |
| (c) Elevator transport (48 feet) | 1 | .038 | .192 | .038 | .035 | .175 | .035 | .044 | .220 | .044 |
| (d) Transport to car (145 feet) | 1 | .034 | .069 | .034 | .031 | .063 | .031 | .042 | .084 | .042 |
| (e) Open car, prepare to load | 2 | .009 | .009 | .018 | .011 | .011 | .022 | .011 | .011 | .022 |
| Handstack in car, hand truck: | | | | | | | | | | |
| (f) At work face inside car | 2 | .043 | .218 | .087 | .048 | .240 | .097 | .047 | [3].141 | .096 |
| (g) On dock | 2 | .010 | .030 | .020 | .011 | .033 | .022 | .005 | .015 | .010 |
| (h) Close car | 2 | .006 | .006 | .012 | .006 | .006 | .012 | .006 | .006 | .012 |
| Total | | .211 | .684 | .299 | .206 | .674 | .300 | .234 | .655 | .325 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296, and bags, 400.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons, and bags, 20.2 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22, and bags, 27.
Packages per unit load: Cans, 54; cartons, 60, and bags, 15.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 5 tiers.
Loads from dock: Cans, 4; cartons, 3, and bags, 3.
Loads from inside car: Cans, 24; cartons, 19, and bags, 24.

[2] Equipment required: Operation (a) one 3,000-pound industrial forklift truck, one 40-inch by 48-inch pallet, one 30-inch by 66-inch hand truck; (b) 1 hand truck, 1 pallet; (c) one 3-ton elevator, 2 hand trucks, 2 pallets; (d) 1 hand truck, 1 pallet; (e) 1 bridge plate; (f) 2 hand trucks, 2 pallets, 1 bridge plate; (g) 1 hand truck, 1 pallet, 1 bridge plate; (h) 1 bridge plate. For a detailed description of the elements composing this operation, see table of element standards in appendix.

[3] One bridge plate, 1 pallet, and 1 hand truck.

Of the 3 package types, cartons were handled in the least elapsed time, and cans and bags moved somewhat more slowly. However, cans and cartons required almost identical amounts of labor, 0.299 and 0.300 man-hour per ton, respectively. Bags at 0.325 man-hour per ton required 8 percent more labor.

Cans and cartons were handled at about the same cost by this handling method, and bags cost about 8 percent more per ton to move out of storage and load into railroad cars (table 31). Total costs for labor and equipment indicate that cans and cartons were handled by this method for $0.55 per ton, and bags for $0.59.

To obtain maximum efficiency when pallets are loaded on hand trucks and an industrial forklift truck is used in this operation, enough hand trucks should be available so that breaking stack and loading are performed without interruption.

Also, in the interest of using warehouse personnel most effectively, a minimum number of men should perform the loading operation, so as to keep crew interference to a minimum.

When speed is the prime requisite in this operation and the maximum economy compatible with speed is desired, 3 men should be used in the storage room, 1 to push loaded hand trucks and supply empties at the stack, and 1 to help the forklift truck operator by positioning the hand trucks. The elevator crew should be composed of 2 men to push loaded hand trucks to the elevator vestibule and return empties to the storage room, if the elevator platforms are large enough to take at least 4 hand trucks. Two crews, of 2 men each, should work inside the car at the work faces. These crews should be serviced by a 2-man crew that pushes loaded hand trucks to the loading crews inside the car, and returns empty hand trucks to the elevator vestibule. Thus, a maximum of 11 men may be used in this job to break the storage room stacks and load the railroad cars. This is only an emergency measure, however, for the most profitable crew disposition is indicated in the tables herewith; that is, 2 men breaking stack, 1 man on the elevator, 1 man pushing on the loading dock, and 2 men in the car. When warehouse traffic volume is heavy, it is usual practice to vary the size of crews to suit conditions on the loading platform.

## PALLETS, HAND TRUCKS AND A WALKIE-TYPE INDUSTRIAL HIGH-LIFT TRUCK

This method is similar to that just described, except that a walkie-type industrial high-lift truck is used instead of an industrial forklift truck for breaking stack at the storage point.

TABLE 31.--Comparative labor and equipment costs for moving 1 ton of 3 specified package types out of storage and loading into railroad cars by use of pallets, hand trucks, and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.211 | [3] 0.684 | 0.299 | 0.12 | 0.43 | 0.55 | 0.63 |
| Cartons.... | .206 | [4] .674 | .300 | .11 | .44 | .55 | .62 |
| Bags....... | .234 | [5] .655 | .325 | .12 | .47 | .59 | .67 |

[1] Transportation distances standardized at 140 feet from stacking point to elevator, 48 feet of elevator travel, and 145 feet from elevator to railroad car.
[2] Computed from "current" wage rates.
[3] Industrial forklift truck, 3,000-pound capacity, 0.019 machine-hour; 28 (40- by 48-inch) pallets, 0.279 machine-hour; 28 hand trucks, 0.279 machine-hour; 3-ton elevator, 0.038 machine-hour; bridge plate, 0.069 machine-hour; total, 0.684 machine-hour.
[4] Industrial forklift truck, 3,000-pound capacity, 0.017 machine-hour; 22 (40- by 48-inch) pallets, 0.273 machine-hour; 22 hand trucks, 0.273 machine-hour; 3-ton elevator, 0.035 machine-hour; bridge plate, 0.076 machine-hour; total, 0.674 machine-hour.
[5] Industrial forklift truck, 3,000-pound capacity, 0.020 machine-hour; 27 (40- by 48-inch) pallets, 0.270 machine-hour; 27 hand trucks, 0.270 machine-hour; 3-ton elevator, 0.044 machine-hour; bridge plate, 0.051 machine-hour; total, 0.655 machine-hour.

Table 32 shows labor and equipment requirements for handling 3 specified package types by this method.

Cans and cartons required 0.308 man-hour and 0.309 man-hour per ton, respectively, while bags required 0.338 man-hour. About one-third of this labor was used to place the bags in position in the railroad car.

The elapsed time to perform this operation was lowest for cartons at 0.211 hour per ton, next lowest for cans at 0.216 hour per ton, and highest for bags at 0.240 hour per ton.

Labor and equipment costs are shown in table 33. Cartons were handled for $0.55 per ton, and cans for $0.01 more. Bags were loaded out at the highest cost, $0.61 per ton. About 80 percent of the cost of this operation was for labor, the rest for equipment.

## HAND TRUCKS AND A WALKIE-TYPE INDUSTRIAL TRACTOR

The empty hand trucks were pushed to the stacking point and the packages were manually removed from the stacks and placed on hand trucks by a 2-man crew. The loaded hand trucks were transported through manually operated storage room doors to the elevators. The hand trucks were pushed into the elevator and were transported to the platform floor. One or more loaded hand trucks were towed to the loading spots by a walkie-type industrial tractor. The car was opened and the loaded trucks were pushed into the empty car and spotted at the work face inside the car. The packages were removed from the truck and handstacked in the car. When the car was loaded to the point where it was no longer possible to push the loads into the car, the hand trucks were spotted on the platform at the car door and the remaining containers were handstacked in the car. The railroad car doors were then closed.

TABLE 32. --Labor and equipment required to move 1 ton of 3 specified package types out of storage and load into a railroad car by use of pallets, hand trucks, and a walkie-type industrial high-lift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack........................ | 2 | 0.023 | 0.069 | 0.046 | 0.021 | 0.063 | 0.042 | 0.027 | 0.081 | 0.054 |
| (b) Transport to elevator (140 feet)... | 1 | .052 | .104 | .052 | .047 | .094 | .047 | .060 | .120 | .060 |
| (c) Elevator transport (48 feet)....... | 1 | .038 | .190 | .038 | .035 | .175 | .035 | .044 | .220 | .044 |
| (d) Transport to car (145 feet)........ | 1 | .034 | .068 | .034 | .031 | .061 | .031 | .038 | .077 | .038 |
| (e) Open car, prepare to load.......... | 2 | .009 | .009 | .018 | .011 | .011 | .022 | .011 | .011 | .022 |
| Handstack, hand truck | | | | | | | | | | |
| (f) At work face inside car.......... | 2 | .044 | .220 | .088 | .049 | .244 | .098 | .048 | [3] .145 | .096 |
| (g) On dock at car door.............. | 2 | .010 | .030 | .020 | .011 | .032 | .022 | .005 | .015 | .010 |
| (h) Close car.......................... | 2 | .006 | .006 | .012 | .006 | .006 | .012 | .007 | .007 | .014 |
| Total........................ | | .216 | .696 | .308 | .211 | .686 | .309 | .240 | .676 | .338 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296, and bags, 400.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73, and bags, 20.2.
Unit loads per carload equivalent: Cans, 28; cartons, 22, and bags, 27.
Packages per unit load: Cans, 54; cartons, 60, and bags, 15.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 5 tiers.
Loads from dock: Cans, 4; cartons, 3, and bags, 3.
Loads from inside car: Cans, 28; cartons, 19, and bags, 24.

[2] Equipment required: Operation (a) one 2,000-pound walkie-type forklift truck, one 30-inch by 66-inch hand truck, one 40-inch by 48-inch pallet; (b) 1 hand truck, 1 pallet; (c) one 3-ton elevator, 2 hand trucks, 2 pallets; (d) 1 hand truck, 1 pallet; (e) 1 bridge plate; (f) 2 hand trucks, 2 pallets, 1 bridge plate; (g) 1 hand truck, 1 pallet, 1 bridge plate; (h) 1 bridge plate. For a detailed description of the elements composing this operation, see table of element standards in appendix.

[3] One bridge plate, 1 pallet, and 1 hand truck.

TABLE 33.--Comparative labor and equipment costs for moving 1 ton of 3 specified package types out of storage and loading into railroad cars by use of pallets, hand trucks, and a walkie-type industrial high-lift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.216 | [3] 0.696 | 0.308 | 0.11 | 0.45 | 0.56 | 0.63 |
| Cartons.... | .211 | [4] .686 | .309 | .10 | .45 | .55 | .62 |
| Bags....... | .240 | [5] .676 | .338 | .12 | .49 | .61 | .70 |

[1] Transportation distances standardized at 140 feet from stacking point to elevator, 48 feet of elevator travel, and 145 feet from elevator to railroad car.

[2] Computed from "current" wage rates.

[3] Walkie-type industrial forklift truck, 3,000-pound capacity, 0.023 machine-hour; 32 hand trucks, 0.283 machine-hour; 32 (40- by 48-inch) pallets, 0.283 machine-hour; 3-ton elevator, 0.038 machine-hour; bridge plate, 0.069 machine-hour; total, 0.696 machine-hour.

[4] Walkie-type industrial forklift truck, 3,000-pound capacity, 0.021 machine-hour; 22 hand trucks, 0.277 machine-hour; 22 (40- by 48-inch) pallets, 0.277 machine-hour; 3-ton elevator, 0.035 machine-hour; bridge plate, 0.076 machine-hour; total, 0.686 machine-hour.

[5] Walkie-type industrial forklift truck, 3,000-pound capacity, 0.027 machine-hour; 27 hand trucks, 0.276 machine-hour; 27 (40- by 48-inch) pallets, 0.276 machine-hour; 3-ton elevator, 0.044 machine-hour; bridge plate, 0.053 machine-hour; total, 0.676 machine-hour.

Labor and equipment requirements per ton for moving out of storage and loading into a railroad car by this method are shown in table 34. Analysis of these requirements covered only 2 package types--cans and cartons. Cans required 0.448 man-hour per ton, while cartons required 0.477 man-hour.

Cans were handled about 5 percent more economically than cartons, at a cost of $0.73 per ton; cartons were handled at a cost of $0.77 per ton (table 35).

TABLE 34.--Labor and equipment required to move 1 ton of 2 specified package types out of storage and load into railroad cars by use of hand trucks and a walkie-type industrial tractor[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | |
|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to elevators (140 feet)................................ | 2 | 0.102 | 0.204 | 0.204 | 0.110 | 0.220 | 0.220 |
| (b) Elevator transport (48 feet)................ | 1 | .041 | .123 | .041 | .041 | .123 | .041 |
| (c) Tow loads from elevator to dock with walkie-type, electric tractor (145 feet). | 1 | .064 | .128 | .064 | .064 | .128 | .064 |
| (d) Open car, prepare to load.................. | 2 | .009 | .009 | .018 | .011 | .011 | .022 |
| Handstack, hand truck: | | | | | | | |
| (e) Inside car.................................. | 2 | .045 | .135 | .090 | .050 | .151 | .100 |
| (f) On platform at car door..................... | 2 | .009 | .019 | .019 | .009 | .018 | .018 |
| (g) Close car.................................... | 2 | .006 | .006 | .012 | .006 | .006 | .012 |
| Total................................ | | .276 | .624 | .448 | .291 | .657 | .477 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500, and cartons, 1,296.
Total gross weight of packages: Cans, 24 tons, and cartons, 20.73.
Unit loads per carload equilvlent: Cans, 30, and cartons, 26.
Packages per unit load: Cans, 51, and cartons, 50.
Unit load stacking: Cans, 17 by 3 tiers, and cartons, 10 by 5 tiers.
Loads from dock: Cans, 4, and cartons, 3.
Loads from inside car: Cans, 26, and cartons, 23.

[2] Equipment required: Operation (a) two 30- by 66-inch hand trucks; (b) 2 hand trucks, one 3-ton elevator; (c) 1 hand truck, one 700-pound walkie-type industrial tractor; (d) 1 bridge plate; (e) 2 hand trucks, 1 bridge plate; (f) 1 hand truck, 1 bridge plate; (g) 1 bridge plate. For detailed description of the elements composing this operation, see table of element standards in the appendix.

TABLE 35.--Comparative labor and equipment costs for moving 1 ton of 2 specified package types out of storage and loading into railroad cars by use of hand trucks and a walkie-type industrial tractor[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.276 | [3] 0.624 | 0.448 | 0.08 | 0.65 | 0.73 | 0.84 |
| Cartons.... | .291 | [4] .657 | .477 | .08 | .69 | .77 | .89 |

[1] Transportation distances standardized at 140 feet from stacking point to elevator, 48 feet of elevator travel, and 145 feet from elevator to railroad car.
[2] Computed from "current" wage rates.
[3] Walkie-type industrial tractor, 700-pound pull, 0.064 machine-hour; 30 hand trucks, 0.450 machine-hour; 3-ton elevator, 0.041 machine-hour; bridge plate, 0.069 machine-hour; total, 0.624 machine-hour.
[4] Walkie-type industrial tractor, 700-pound pull, 0.064 machine-hour; 26 hand trucks, 0.476 machine-hour; 3-ton elevator, 0.041 machine-hour; bridge plate, 0.076 machine-hour; total, 0.657 machine-hour.

The use of a walkie-type industrial tractor reduces worker fatigue when the distance from the loading spots on the docks to the elevator vestibule is great. When short distances are involved, use of the electric tractor is not justified.

When a walkie-type industrial tractor is used, it is more important than ever that the top tiers of the hand-truck loads be tied with rope (usually precut sashcord, to save time), so that the tractor-drawn hand truck is pulled as rapidly as the operator guiding it may safely walk.

To make this operation more efficient, attention should be directed to the hand-truck couplings. These coupling devices should permit fast action both for hooking on and for unfastening the truck. Also, whenever possible more than one truck at a time should be towed.

## HAND TRUCKS AND A GRAVITY ROLLER CONVEYOR

This method was used in a very limited way in the selected warehouses for loading railroad cars. For this reason, the costs of handling only 32-pound cartons were computed. This method was identical with that described for the hand truck except that, when the car was loaded to the point where it was no longer possible to push the loads into the car, a short section of gravity roller conveyor was mounted in the car door with one end extending over the platform. The loaded hand trucks were then spotted at the platform end of the roller conveyor. The containers were placed on the conveyor and moved by gravity to the end of the conveyor inside the car, from which they were removed and stacked in the cars.

Table 36 presents the labor and equipment times involved in moving out of storage and loading into a railroad car by this method. Manual handling of the cartons accounted for most of the labor.

Use of the gravity roller conveyor did not tend to decrease the time of loading a railroad car. How rapidly the conveyor could be installed in the loading spot spanning the gap between the edge of the platform and the car depended to a large extent on whether or not the platform workers could locate the conveyor section quickly and could find the supports for it. The cost per ton by this method of handling, at current wage rates, was $0.77 per ton (table 37).

Warehousemen trying this method should use a minimum of workers in the loading operation when the last containers are being placed in the car by use of the roller conveyor. The roller conveyor, while not speeding up the loading operation, does much to reduce worker fatigue when cartons or crate-type containers are handled. Furthermore, the last few cartons are loaded by a worker standing on the bridge plate, and the gravity roller conveyor takes less space on the bridge plate than does a hand truck; therefore, it is safer for the worker to have only a 12-inch-wide conveyor on the bridge plate. The conveyor and its supports should be kept in a convenient location on or near the loading dock.

TABLE 36.--Labor and equipment required to move 1 ton of 32-pound cartons out of storage and load into a railroad car by use of hand trucks and a gravity roller conveyor[1]

| Operation element[2] | Workers | Elapsed time | Equipment | Productive labor |
|---|---|---|---|---|
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to elevator (140 feet)...................... | 2 | 0.111 | 0.222 | 0.222 |
| (b) Elevator transport (48 feet)...... | 1 | .041 | .123 | .041 |
| (c) Open car, prepare to unload....... | 2 | .011 | .011 | .021 |
| (d) Transport loads, elevator to loading dock (145 feet) | 1 | .036 | .036 | .036 |
| (e) Handstack, hand truck inside car.. | 2 | .050 | .150 | .100 |
| (f) Set up roller conveyor............ | 2 | .001 | .003 | .002 |
| (g) Handstack, hand truck on dock..... | 2 | .024 | .072 | .048 |
| (h) Remove conveyor, close car........ | 2 | .007 | .014 | .014 |
| Total........................ | | .281 | .631 | .484 |

[1] Loading data: Cartons per carload equivalent, 1,296; total gross weight of cartons, 20.73 tons; unit loads per carload equivalent, 26; cartons per unit load, 50; unit load stacking, 10 by 5 tiers; loads from dock, 3, and loads from inside car, 23.

[2] Equipment required: Operation (a) two 30-inch by 66-inch hand trucks; (b) 2 hand trucks, one 3-ton elevator; (c) 1 bridge plate; (d) 1 hand truck; (e) 2 hand trucks, 1 bridge plate; (f) 1 bridge plate, one 12-inch by 10-foot gravity roller conveyor; (g) 1 hand truck, 1 bridge plate, 1 gravity roller conveyor; (h) 1 bridge plate, 1 gravity roller conveyor. For a detailed description of the elements composing this operation, see table of element standards in appendix.

TABLE 37.--Comparative labor and equipment costs for moving 1 ton of 32-pound cartons out of storage and loading them into railroad cars by use of hand trucks and a gravity roller conveyor[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cartons... | 0.281 | [3] 0.631 | 0.484 | 0.07 | 0.70 | 0.77 | 0.89 |

[1] Transportation distances standardized at 140 feet from stacking point to elevators, 48 feet of elevator travel, and 145 feet from elevator to the railroad car.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.094 machine-hour; 3-ton elevator, 0.041 machine-hour; 26 hand trucks, 0.464 machine-hour; gravity roller conveyor, 0.032 machine-hour; total, 0.631 machine-hour.

## COMPARISON OF SELECTED METHODS FOR MOVING OUT OF STORAGE AND LOADING INTO RAILROAD CARS IN MULTISTORY WAREHOUSES

In comparing the several combinations of equipment and handling methods in multistory warehouses for the removal of merchandise from storage, transporting to loading platform, and loading into railroad cars, it was found through time studies that, when pallets, hand trucks, and an industrial forklift truck were used, invariably the operation was performed faster and at lower cost per ton than by any of the other methods evaluated. From table 38, it can be seen that, while the equipment was more costly, it replaced a part of high-priced labor involved. Manual labor was invariably more expensive than handling equipment when large volumes were handled. Therefore, for the methods observed in this study, the general statement may be made that handling equipment, in most instances, will pay for itself, usually by reducing the cost of the operation; and in all instances, it will reduce worker fatigue.

Since it sometimes happens that one piece of handling equipment or one handling method may not be as efficient with every container type, the handling methods were evaluated by type of container. It is understood, of course, that physical limitations of plant structure and investment capital available for equipment purchases restrict the use of certain types of mechanical equipment.

Cans.--The effectiveness of each method considered was the same, in both speed of operation and cost of labor and equipment involved; that is, the faster the operation, the cheaper it was, and vice versa. The method using pallets, hand trucks, and an industrial forklift truck required an elapsed time of 0.211 hour per ton, and a cost of $0.55 per ton. Use of a walkie-type industrial high-lift truck in place of the industrial forklift truck was 2.3 percent slower and about 1 cent a ton more expensive.

Hand trucks alone required an elapsed time of 0.249 hour per ton, 18 percent more than the best method just described. Costs for hand trucks alone amounted to $0.68 per ton.

When hand trucks and a walkie-type industrial tractor were used, the elapsed time jumped 30 percent to 0.276 hour per ton and costs increased $0.18 per ton to $0.73 per ton. This increase in cost may be justified in some instances by a reduction in worker fatigue when tractors of appropriate capacity are used.[8]

Cartons.--Cartons or crates or other cubical, rigid containers were handled most efficiently, both from a time and cost standpoint, when pallets, hand trucks, and an industrial forklift truck were used. Elapsed time amounted to 0.206 hour per ton for the 32-pound cartons handled. The cost was $0.55 per ton.

The elapsed time required for pallets, hand trucks, and a walkie-type industrial high-lift truck was 0.211 hour per ton, or 2.4 percent more than the method just described. This is comparable to the experience in handling cans in this operation. Costs were $0.55 per ton. Since both the cost and time elements for these 2 methods are so closely related, the choice of using 1 or the other of these 2 methods would depend naturally on other circumstances, such as convenience, building structure, and other handling operations involved.

Hand trucks alone, with an elapsed time of 0.264 hour per ton, required 28 percent more time than the fastest method. It also cost $0.17, or 31 percent, more to use hand trucks alone than to use the faster industrial forklift truck method.

[8] The walkie-type industrial tractor used in the plant observed in this study had a minimum drawbar pull of 200 pounds and a maximum of 700 pounds.

TABLE 38.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage and loading into railroad cars in multistory warehouses, by specified types of equipment[1]

| Types of packages and methods | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans: | | | | | | | |
| Hand trucks | 0.249 | 0.532 | 0.420 | 0.07 | 0.61 | 0.68 | 0.78 |
| Pallets, hand trucks, and industrial forklift truck | .211 | .684 | .299 | .12 | .43 | .55 | .63 |
| Pallets, hand trucks, and walkie-type industrial high-lift truck | .216 | .696 | .308 | .11 | .45 | .56 | .63 |
| Hand trucks and walkie-type industrial tractor | .276 | .624 | .448 | .08 | .65 | .73 | .84 |
| Cartons: | | | | | | | |
| Hand trucks | .264 | .566 | .449 | .07 | .65 | .72 | .83 |
| Pallets, hand trucks, and industrial forklift truck | .206 | .674 | .300 | .11 | .44 | .55 | .62 |
| Pallets, hand trucks, and walkie-type industrial high-lift truck | .211 | .686 | .309 | .10 | .45 | .55 | .62 |
| Hand trucks and walkie-type industrial tractor | .291 | .657 | .477 | .08 | .69 | .77 | .89 |
| Hand trucks and gravity roller conveyor | .281 | .631 | .484 | .07 | .70 | .77 | .89 |
| Bags: | | | | | | | |
| Hand trucks | .233 | .454 | .390 | .07 | .56 | .63 | .73 |
| Pallets, hand trucks, and industrial forklift truck | .234 | .655 | .325 | .12 | .47 | .59 | .67 |
| Pallets, hand trucks, and walkie-type industrial high-lift truck | .240 | .676 | .338 | .12 | .49 | .61 | .70 |
| Carcasses: | | | | | | | |
| Hand trucks | .571 | 1.132 | .935 | .18 | 1.36 | 1.54 | 1.77 |

[1] Transportation distances were standardized at 140 feet from stacking point to elevator, 48 feet elevator transport, and 145 feet from elevator to car.
[2] Based on "current" wage rates.

The gravity roller conveyor used in combination with the hand trucks took 36 percent more time than the industrial forklift truck method and was 40 percent more costly, because this method required more hand labor for setting up and removing the conveyor. When hand trucks and a walkie-type industrial tractor were used, the elapsed time averaged 0.291 hour per ton, or 41 percent more than when the industrial forklift truck was used. Costs were $0.22, or 40 percent, more per ton than for the industrial forklift truck method.

Bags.--The range in elapsed times for the 3 methods used in handling bags in this operation shows less than a 1-percent spread; that is, the difference between the fastest and the slowest method was less than 0.007 hour per ton. In this respect, bags handled by hand trucks alone were handled more quickly than with pallets on hand trucks used in combination with either an industrial forklift truck or a walkie-type industrial high-lift truck.

Carcasses.--Mostly, the 5 multistory warehouses observed in this survey used hand trucks alone to handle animal carcasses. The difficulty in stacking the irregular-shaped carcasses--in this instance, 200-pound beef hindquarters--made this task time-consuming and costly. Carcass handling for this operation averaged 0.571 hour of elapsed time per ton, which was 106 percent more than for can handling, 96 percent more than for carton handling, and 138 percent more than for bag handling, even when the slowest of the methods was considered for each of these container types. In all instances, the cost of handling carcasses was more than double that of the most uneconomical method used for each of the other three container types.

Figure 28 compares the elapsed times, in hours per ton, for moving out of storage, transporting to the loading platform, and loading into railroad cars for each container type, by a specific handling method. This graphic presentation shows that, in loading into railroad cars, the time required to load a ton of cans, cartons, or bags was about the same, except when the gravity roller conveyor was used in stacking the last few cartons in the car before closing the doors. This use of the gravity roller conveyor increased the average time required by 0.021 hour, or almost 30 percent, per ton over the time required when no conveyor was used. For a carload equivalent of 20.73 tons of carton-type containers, this meant an increase of 0.437 hour, or 26 minutes per car loading.

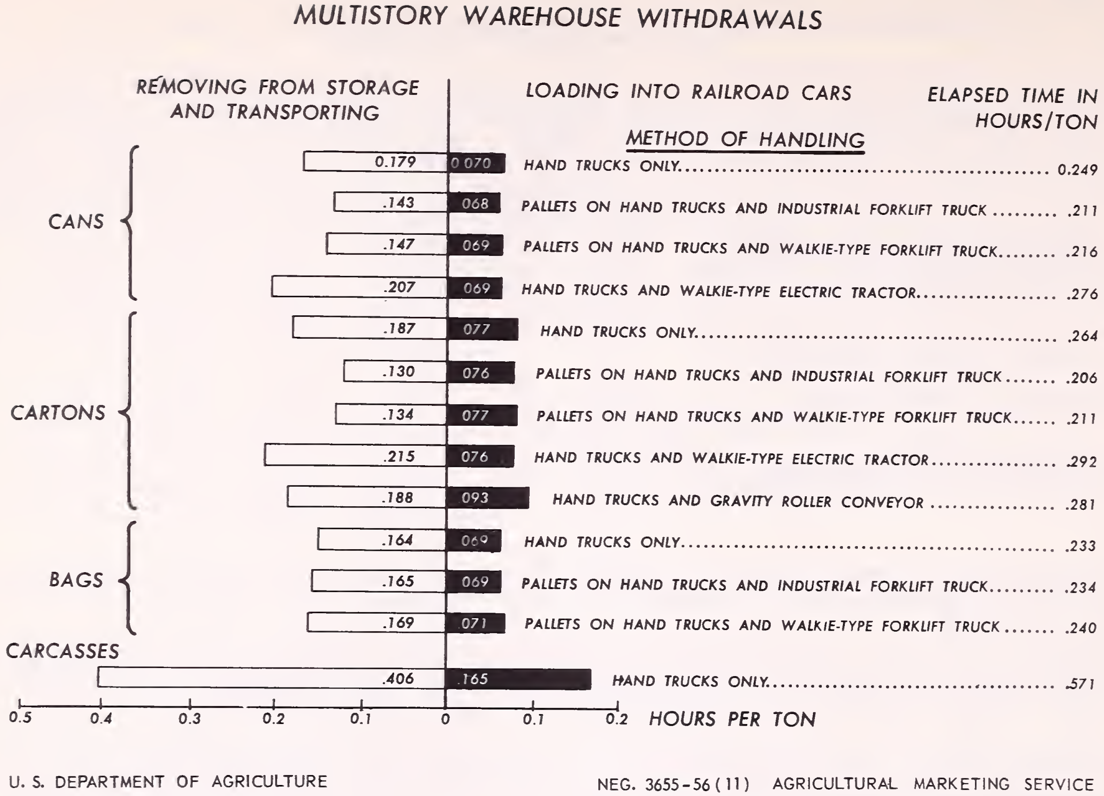


Figure 28.--Elapsed time in hours per ton for removing from storage in a multistory warehouse and loading into railroad cars, by container type and handling method.

Since the time for loading into the railroad car was practically the same for all the container types except animal carcasses, it is apparent that the stackbreaking and transporting operations must indicate what combination of handling equipment should be used to do the job in the shortest time. It may be, however, that the method using the shortest time may not be best in a given warehouse. This analysis does not presume that the methods described are the best possible for multistory warehouses; on the contrary, modifications of these methods and recommendations for improving warehouse handling in the selected warehouses are suggested.

## Single-Story Warehouses

The single-story warehouse permits a high degree of operating efficiency. It permits the use of the latest materials-handling equipment and it eliminates some of the bottlenecks that frequently hamper operations in the multistory plant. Because almost all merchandise is handled in palletized unit loads, handstacking of individual packages is seldom required in the storage rooms. Handstacking of packages in railroad car loading is one of the unavoidable practices that slow down the loading of railroad cars. However, the single-story warehouse can handle inbound and outbound cold storage merchandise at decidedly less cost than is possible in multistory warehouses, considering only handling costs and not land costs, building costs, or the like.

### PALLETS AND AN INDUSTRIAL FORKLIFT TRUCK

In this method, loaded pallets were picked up and moved out of the storage room, transported through automatically operated storage room doors to the loading platform, and placed on the railroad car floor racks inside the door or on the dock at the car door,

by use of an industrial forklift truck. The loaded pallets were placed inside the car door until the car had been loaded to the point where there was no longer room for a pallet. The remaining pallets were placed on the platform, as close as possible to the car door. The containers were handstacked in the cars from the pallets. (This method is not recommended in loading cars with small containers when pallet dollies are not used, as the entire contents of the car must be carried from the pallets to the work face inside the car, requiring a large number of round trips from the pallet to the work face. Thus, pallet dollies should be used to transport the loaded pallet to the work face.)

Table 39 shows the labor and equipment requirements per ton of outgoing merchandise handled in the selected single-story warehouse.

The elapsed times in hours to move 1 ton out of storage and into a railroad car by the handling method described were: 0.141 hour per ton for bags, 0.171 for cans, 0.173 for cartons, and 0.383 for carcasses. Labor requirements followed the same pattern.

The costs shown in table 40 indicate that bags were handled most effectively by the handling method described, and next were cans, followed closely by cartons. Carcasses were handled least efficiently.

The equipment cost for handling bags was found to be $0.07 per ton, which is $0.01 less than for cans and cartons. Equipment to handle carcasses by this method cost $0.22, over 3 times as much as for bags. Total costs for handling bags, for equipment and labor combined, based on wage rates at the time this survey was made, were only $0.38 per ton when pallets and an industrial fork truck were used. Cans and cartons were handled at costs of $0.47 and $0.48 per ton, respectively. These costs were 24 percent and 26 percent, respectively, higher than the cost of handling bags. Carcasses cost $1.02 per ton to handle in this operation, which is $0.64, or about 170 percent, more per ton than for bag handling.

The over-all costs for performing this operation, that is, removing from storage, transporting, and loading into railroad cars, can be held to a minimum by using the fewest workers possible consistent with the required, or desired, speed of loading a railroad car. This is especially important when loading the last few containers into the car, when the pallets are on the platform outside the car door.

TABLE 39.--Labor and equipment required to move 1 ton of 4 specified package types out of storage and load into railroad cars by use of pallets and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | | 200-pound carcasses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to car (300 feet) | 1 | 0.065 | 0.130 | 0.065 | 0.059 | 0.118 | 0.059 | 0.059 | 0.118 | 0.059 | 0.180 | 0.360 | 0.180 |
| (b) Open car, prepare to load | 2 | .009 | .009 | .018 | .011 | .011 | .022 | .011 | .011 | .022 | .015 | .015 | .030 |
| (c) Place loads inside car door | 1 | .012 | .036 | .012 | .011 | .033 | .011 | .012 | .036 | .012 | .035 | .105 | .035 |
| (d) Handstack, pallet inside car door | 2 | .065 | .130 | .130 | .071 | .143 | .142 | .042 | .085 | .084 | .117 | .234 | .234 |
| (e) Place loads on dock at car door | 1 | .002 | .006 | .002 | .001 | .003 | .001 | .002 | .006 | .002 | .004 | .012 | .004 |
| (f) Handstack, pallet on dock | 2 | .010 | .021 | .021 | .012 | .024 | .024 | .006 | .012 | .012 | .016 | .031 | .031 |
| (g) Close car | 2 | .006 | .006 | .012 | .006 | .006 | .012 | .007 | .007 | .014 | .009 | .009 | .018 |
| (h) Return empty pallets to stock (150 feet) | 1 | .002 | .004 | .002 | .002 | .004 | .002 | .002 | .004 | .002 | .007 | .014 | .007 |
| Total | | .171 | .342 | .262 | .173 | .342 | .273 | .141 | .279 | .207 | .383 | .780 | .539 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296; bags, 400, and carcasses, 150.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons; bags, 20.2 tons, and carcasses, 15 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22; bags, 23, and carcasses, 50.
Packages per unit load: Cans, 54; cartons, 60; bags, 18, and carcasses, 3.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers; bags, 3 by 6 tiers, and carcasses, 3 per pallet.
Loads from dock: Cans, 4; cartons, 3; bags, 3, and carcasses, 6.
Loads from inside car: Cans, 24; cartons, 19; bags, 20, and carcasses, 44.

[2] Equipment required: Operation (a) one 3,000-pound industrial forklift truck, one 40-inch by 48-inch pallet; (b) 1 bridge plate; (c) 1 industrial forklift truck, 1 pallet, 1 bridge plate; (d) 1 pallet, 1 bridge plate; (e) 1 industrial forklift truck, 1 pallet, 1 bridge plate; (f) 1 pallet, 1 bridge plate; (g) 1 bridge plate; (h) 1 industrial forklift truck, 1 pallet. For a detailed description of the elements composing this operation, see table of element standards in appendix.

TABLE 40.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage and loading into railroad cars by use of pallets and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans...... | 0.171 | [3] 0.342 | 0.262 | 0.08 | 0.39 | 0.47 | 0.53 |
| Cartons... | .173 | [4] .342 | .273 | .08 | .40 | .48 | .55 |
| Bags...... | .141 | [5] .279 | .207 | .07 | .31 | .38 | .43 |
| Carcasses. | .383 | [6] .780 | .539 | .22 | .80 | 1.02 | 1.16 |

[1] Transportation distances standardized at 300 feet from storage position to the railroad car and 150 feet in returning empty pallets to storage.
[2] Computed from "current" wage rates.
[3] Bridge plate, 0.105 machine-hour; 3,000-pound industrial forklift truck, 0.081 machine-hour; 28 (40- by 48-inch) pallets, 0.156 machine-hour; total, 0.342 machine-hour.
[4] Bridge plate, 0.112 machine-hour; 3,000-pound industrial forklift truck, 0.073 machine-hour; 22 (40- by 48-inch) pallets, 0.157 machine-hour; total, 0.342 machine-hour.
[5] Bridge plate, 0.080 machine-hour; 3,000-pound industrial forklift truck, 0.075 machine-hour; 23 (40- by 48-inch) pallets, 0.124 machine-hour; total, 0.279 machine-hour.
[6] Bridge plate, 0.195 machine-hour; 3,000-pound industrial forklift truck, 0.226 machine-hour; 50 (40- by 48-inch) pallets, 0.359 machine hour; total, 0.780 machine-hour.

When speed is the prime requisite, the stacking operation can be speeded by using additional workers in the loading crews. This tends to reduce the elapsed time required to load, but increases the cost per ton handled since there is an increase in man-hours due to waiting time for the spotting of pallet loads in the car door.

## PALLETS, SEMILIVE SKIDS, JACK, AND AN INDUSTRIAL FORKLIFT TRUCK

By this method, loaded pallets are moved out of the storage room by an industrial forklift truck, transported through automatically operated doors to the loading platform, and placed in temporary storage locations there until required for loading. The loaded pallets are then picked up from the platform by the forklift truck and put onto semilive skids inside the car door. The pallet-loaded skid is then pulled to the work face inside the car with a jack, or, later in the loading, the loaded pallets are placed on skids on the platform at the car door. The containers are manually stacked in the car from the pallets until the car is loaded to the point where the loaded pallets can no longer be moved inside the car. The remaining pallet loads are placed on the platform close to the car door and the containers are handstacked in the car.

Table 41 shows elapsed times, equipment time in hours per ton, and productive labor in man-hours per ton required for this operation.

It is interesting to note that the elapsed times for the operation for each of the container types was the same--0.152 hour per ton.

Since the elapsed time for each of the three container types was the same, but the labor inputs were not the same, the comparative equipment times and costs for each container type measure the differences in total costs per ton handled. These costs are $0.41 per ton for bags and $0.42 for cans and cartons, based on current wages (table 42).

TABLE 41.--Labor and equipment required to move 1 ton of 3 specified package types out of storage and load into a railroad car by use of pallets, semilive skids, jack, and an industrial forklift truck[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor | Elapsed time | Equipment | Productive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to car (300 feet)........................... | 1 | 0.065 | 0.130 | 0.065 | 0.059 | 0.119 | 0.059 | 0.063 | 0.126 | 0.063 |
| (b) Open car, prepare to load......... | 2 | .009 | .009 | .018 | .011 | .011 | .022 | .011 | .011 | .022 |
| (c) Place load on skid in car door..... | 1 | .012 | .036 | .012 | .011 | .034 | .011 | .011 | .035 | .011 |
| (d) Handstack, pallet on skid inside car.............................. | 2 | .045 | .270 | .090 | .050 | .300 | .100 | .050 | [3] .200 | .100 |
| (e) Place load on dock at car door..... | 1 | .002 | .006 | .002 | .002 | .006 | .002 | .002 | .006 | .002 |
| (f) Handstack, pallet on dock.......... | 2 | .011 | .022 | .022 | .011 | .022 | .022 | .006 | .012 | .012 |
| (g) Close car......................... | 2 | .006 | .006 | .012 | .006 | .006 | .013 | .007 | .007 | .013 |
| (h) Return empty pallets to stock (150 feet)............................ | 1 | .002 | .005 | .002 | .002 | .004 | .002 | .002 | .004 | .002 |
| Total............................ | | .152 | .484 | .223 | .152 | .502 | .231 | .152 | .401 | .225 |

[1] Loading data:
Packages per carload equivalent: Cans, 1,500; cartons, 1,296, and bags, 400.
Total gross weight of packages: Cans, 24 tons; cartons, 20.73 tons, and bags, 20.2 tons.
Unit loads per carload equivalent: Cans, 28; cartons, 22, and bags, 23.
Packages per unit load: Cans, 54; cartons, 60, and bags, 18.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 12 by 5 tiers, and bags, 3 by 6 tiers.
Loads from dock: Cans, 4; cartons, 3, and bags, 3.
Loads from inside car: Cans, 24; cartons, 19, and bags, 20.

[2] Equipment required: Operation (a) one 3,000-pound industrial forklift truck, one 40-inch by 48-inch pallet; (b) 1 bridge plate; (c) 1 industrial forklift truck, 1 pallet, 1 bridge plate; (d) two 36-inch by 60-inch semilive skids and one 3,000-pound jack, 2 pallets, 1 bridge plate; (e) 1 industrial forklift truck, 1 pallet, 1 bridge plate; (f) 1 pallet, 1 bridge plate; (g) 1 bridge plate; (h) 1 industrial forklift truck, 1 pallet. For a detailed description of the elements composing this operation, see table of element standards in appendix.

[3] One skid, 1 jack, 1 pallet, and 1 bridge plate.

TABLE 42.--Comparative labor and equipment costs for moving 1 ton of 3 specified package types out of storage and loading into railroad cars by use of pallets, semilive skids, jacks, and a forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.152 | [3] 0.484 | 0.223 | 0.09 | 0.33 | 0.42 | 0.45 |
| Cartons.... | .152 | [4] .502 | .231 | .08 | .34 | .42 | .48 |
| Bags....... | .152 | [5] .401 | .225 | .08 | .33 | .41 | .47 |

[1] Transportation distances standardized at 300 feet from storage position to the railroad car and 150 feet in returning empty pallets to storage.

[2] Computed from "current" wage rates.

[3] Bridge plate, 0.082 machine-hour; 28 (36- by 60-inch) semilive skids, 0.090 machine-hour; skid jack, 0.045 machine-hour; 3,000-pound industrial forklift truck, 0.082 machine-hour; 28 (40- by 48-inch) pallets, 0.182 machine-hour; total, 0.484 machine-hour.

[4] Bridge plate, 0.091 machine-hour; 22 (36- by 60-inch) semilive skids, 0.100 machine-hour; skid jack, 0.050 machine-hour; 3,000-pound industrial forklift truck, 0.076 machine-hour; 22 (40- by 48-inch) pallets, 0.186 machine-hour; total, 0.502 machine-hour.

[5] Bridge plate, 0.088 machine-hour; 23 (36- by 60-inch) semilive skids, 0.050 machine-hour; skid jack, 0.050 machine-hour; 3,000-pound industrial forklift truck, 0.079 machine-hour; 23 (40- by 48-inch) pallets, 0.134 machine-hour; total, 0.401 machine-hour.

To reduce crew waiting time as much as possible, it is advisable to have several pallet dollies or semilive skids near the car door, so that the forklift operator will be able to deposit his pallet loads on a skid or dolly and then return immediately to the storage room for another loaded pallet. Furthermore, the car loading crew will have a supply of loaded pallets on hand, ready to pull into the car without waiting for return of the forklift operator. Of course, when dock and car floor are at different levels, it may be easier

on the workers and also more economical for the forklift operator to place the pallets in the car door on a skid or dolly. Also, the forklift operator can place an additional load within the car provided no interference results with the loading crew inside the car.

## COMPARISON OF SELECTED METHODS FOR MOVING OUT OF STORAGE AND LOADING INTO RAILROAD CARS IN A SINGLE-STORY WAREHOUSE

In the single-story warehouse studied, the two principal materials-handling methods observed were the same for both the receiving and the loading-out jobs. This warehouse used (a) pallets and an industrial forklift truck, and (b) pallets, semilive skids, jacks, and an industrial forklift truck. These two handling methods are compared in table 43.

Cans. --Cans were handled 9 percent faster when loaded pallets were placed on semilive skids and pulled to the work face inside the car with jacks, than when pallets alone were used and the handlers had to pick the cans from the pallet in the car door and carry them to the work face. The saving of 0.019 hour per ton meant that it was 11 percent, or $0.05 per ton, more economical to use the skid and jack, even when the costs of the skid and jack were included in the computations.

Cartons. --It was found that cartons were handled 12 percent faster and more economically when skids and jacks were used than when pallets alone were used. This represented a reduction of 0.021 hour per ton in elapsed time, and a saving of $0.06 per ton, including the cost of the extra equipment.

Bags. --Bags were handled 7 percent, or 0.011 hour per ton, faster when pallets alone were used, representing a saving of $0.03 per ton based on current wages. A certain amount of worker fatigue is eliminated in transporting the bags from the pallet in the car door to the work face when skid-jacks are used. The increase in costs for the additional equipment may be offset by its intangible effects on improved worker morale.

Carcasses. --Semilive skids and jacks were not used to handle carcasses in the single-story warehouse participating in this study. However, elapsed time and costs per ton for handling carcasses were compared with those for the other container types. It was found that, even when compared with the costlier methods of performing the loading-out job for carcasses, it cost $0.55 less to handle a ton of cans, $0.54 less to handle cartons, and $0.61 less to handle bags, based on current wage rates.

Figure 29 gives a graphic comparison of the elapsed times for the 2 principal methods of handling used in the single-story warehouse observed in this study.

**TABLE 43.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage and loading into railroad cars in a single-story warehouse by use of specified methods and types of equipment[1]**

| Type of package and method used | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time[2] | Total labor | Equipment | Labor[3] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans: | | | | | | | |
| Pallets and an industrial forklift truck..... | 0.171 | 0.342 | 0.262 | 0.08 | 0.39 | 0.47 | 0.53 |
| Pallets, semilive skids, jacks, and an industrial forklift truck.................. | .152 | .484 | .223 | .09 | .33 | .42 | .45 |
| Cartons: | | | | | | | |
| Pallets and an industrial forklift truck..... | .173 | .342 | .273 | .08 | .40 | .48 | .55 |
| Pallets, semilive skids, jacks, and an industrial forklift truck.................. | .152 | .502 | .231 | .08 | .34 | .42 | .48 |
| Bags: | | | | | | | |
| Pallets and an industrial forklift truck..... | .141 | .279 | .207 | .07 | .31 | .38 | .43 |
| Pallets, semilive skids, jacks, and an industrial forklift truck.................. | .152 | .401 | .225 | .08 | .33 | .41 | .47 |
| Carcasses: | | | | | | | |
| Pallets and an industrial forklift truck..... | .383 | .780 | .539 | .22 | .80 | 1.02 | 1.16 |

[1] Transportation distances were standardized at 300 feet from storage point to railroad car, and 150 feet in returning empty pallets to storage.
[2] For equipment time see tables 41 and 42.
[3] Computed from "current" wage rates.

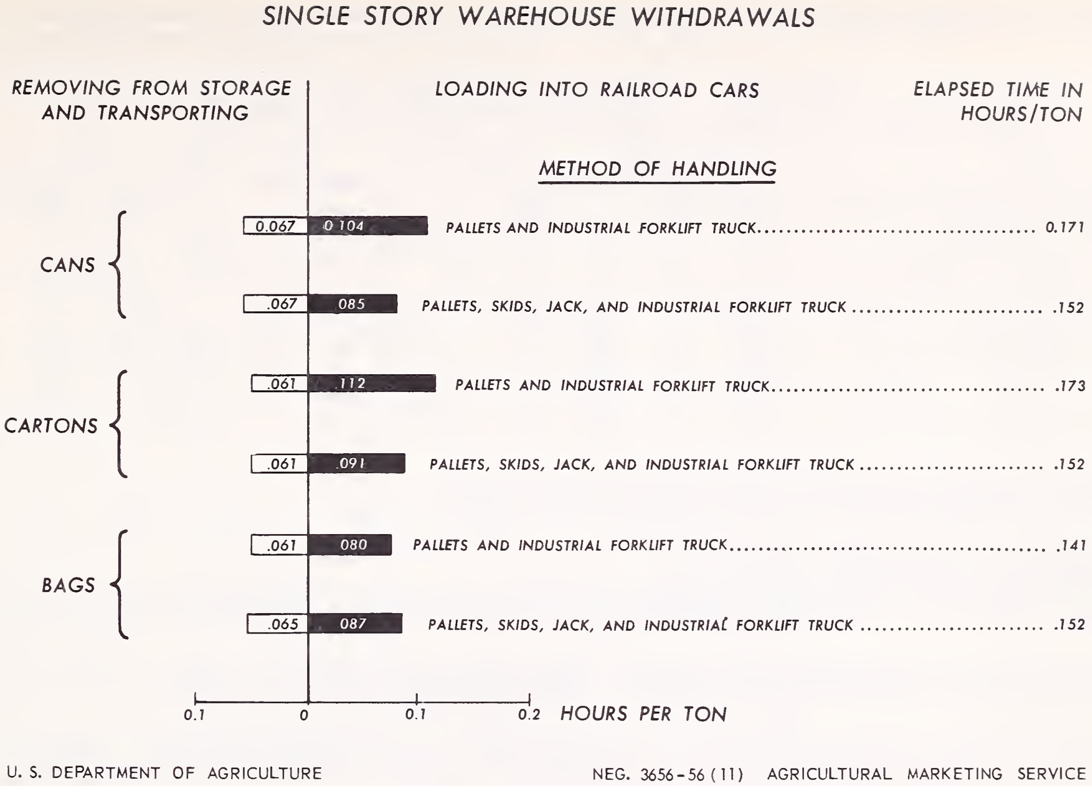


Figure 29.--Elapsed time in hours per ton for removing from storage in a single-story warehouse and loading into railroad cars, by container type and handling method.

## MOVING OUT OF STORAGE AND LOADING INTO HIGHWAY TRUCKS

Methods of loading out highway trucks were studied at the selected warehouses. Because of the different shapes and designs of railroad cars and highway trucks, different space considerations are involved in these two types of carriers which give different loading and unloading time values and costs. Therefore, the methods described below are included, even though, as methods, they are similar to those previously described for loading railroad cars.

### Multistory Warehouses

#### HAND TRUCKS

The hand-truck method is similar to one described in the previous section for railroad cars, except that it was used here to load highway trucks and trailers. Empty hand trucks were taken to the storage room, where the containers were handstacked on them from the stacks by a 2-man crew. The loaded hand trucks were moved to and onto the elevators through manually operated storage room doors. The hand trucks were transported to the dock floor and pushed off the elevator to the loading point. The loaded hand trucks were then moved into the body of the empty highway truck or trailer and placed at the work face. The containers were then handstacked in the highway truck. When the trailer was loaded to the point where it was no longer possible to push the loads into the trailer body, the hand trucks were placed on the loading platform at the tail gate.

Elapsed times required per ton for this entire operation were 0.240 hour for bags, 0.258 hour for cans, 0.270 hour for cartons, and 0.584 hour for carcasses (table 44).

TABLE 44.--Labor and equipment required to move 1 ton of 4 specified package types out of storage and load highway trucks by use of hand trucks[1]

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | | 200-pound carcasses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to elevator (140 feet) | 2 | 0.102 | 0.204 | 0.204 | 0.109 | 0.218 | 0.218 | 0.090 | 0.180 | 0.180 | 0.204 | 0.408 | 0.408 |
| (b) Elevator transport(48 feet) | 1 | .041 | .123 | .041 | .041 | .124 | .041 | .042 | .126 | .042 | .112 | .336 | .112 |
| (c) Open trailer, prepare to load | 2 | .012 | .012 | .024 | .012 | .012 | .024 | .015 | .015 | .030 | .019 | .019 | .037 |
| (d) Transport loads, elevator to loading dock (145 feet) | 1 | .036 | .036 | .036 | .036 | .036 | .036 | .037 | .037 | .037 | .098 | .098 | .098 |
| Handstack hand truck: | | | | | | | | | | | | | |
| (e) At work face inside trailer | 2 | .053 | .106 | .106 | .057 | .114 | .114 | .047 | .095 | .094 | .127 | .254 | .254 |
| (f) On dock at tail gate | 2 | .011 | .022 | .022 | .012 | .024 | .024 | .006 | .012 | .012 | .019 | .038 | .038 |
| (g) Close trailer | 2 | .003 | .003 | .006 | .003 | .003 | .006 | .003 | .003 | .006 | .005 | .005 | .010 |
| Total | | .258 | .506 | .439 | .270 | .531 | .463 | .240 | .468 | .401 | .584 | 1.158 | .957 |

[1] Loading data:
Packages per truckload equivalent: Cans, 1,000; cartons, 1,000; bags, 250, and carcasses, 100.
Total gross weight of packages: Cans, 16 tons; cartons, 16 tons; bags, 12.63 tons, and carcasses, 10 tons.
Unit loads per carload equivalent: Cans, 20; cartons, 20; bags, 16, and carcasses, 34.
Packages per unit load: Cans, 51; cartons, 50; bags, 16, and carcasses, 3.
Unit load stacking: Cans, 17 by 3 tiers; cartons, 10 by 5 tiers; bags, 4 by 4 tiers, and carcasses, 3 perhand truck.
Loads from dock: Cans, 3; cartons, 3; bags, 2, and carcasses, 5.
Loads from inside car: Cans, 17; cartons, 17; bags, 14, and carcasses, 29.

[2] Equipment required: Operation (a) two 30- by 66-inch hand trucks; (b) one 3-ton elevator, 2 hand trucks; (c) 1 bridge plate; (d) 1 hand truck; (e) 1 hand truck, 1 bridge plate; (f) 1 hand truck, 1 bridge plate; (g) bridge plate. For a detailed description of the elements composing this operation, see table of element standards in appendix.

Labor required followed the same pattern, bags requiring 0.401 man-hour per ton, cans 0.439 man-hour, cartons 0.463 man-hour, and carcasses 0.957 man-hour.

The rapidity with which bags can be handled onto and off the hand trucks, using 2 men per bag, brought the cost of each ton handled down to $0.65 for labor and equipment (table 45). Cans were handled at a cost of $0.71, or 9 percent more per ton than bags; cartons were next in order at a cost of $0.74, or 14 percent more per ton than bags; followed by carcasses at a cost of $1.57, or 141 percent more per ton than bags.

## Single-Story Warehouses

### PALLETS, SEMILIVE SKIDS, JACK, AND AN INDUSTRIAL FORKLIFT TRUCK

This method is similar to the method discussed earlier for loading railroad cars. Loaded pallets were picked up by an industrial forklift truck, moved out of the storage room through automatically operated storage room doors, transported to the platform, and placed in a temporary storage location on the platform until required for loading. The loaded pallets were then picked up from the dock by an industrial forklift truck and placed on semilive skids or pallet dollies on the highway truck or trailer tail gate. The skid or dolly and the pallet were moved to the work face in the truck. Then containers were hand-stacked in the truck or trailer body from the pallets until pallets could no longer be placed inside the truck. The remaining pallet loads were placed on the platform close to the tail gate of the highway truck or trailer and the containers were manually stowed.

As shown in table 46, the elapsed time required to move 1 ton of bags out of storage and load into a highway truck was 0.141 hour. Cans required an elapsed time of 0.161 hour per ton, cartons 0.155 hour, and carcasses 0.406 hour. Labor required followed the same general pattern as the elapsed time.

Table 47 shows that the labor and equipment costs per ton were $0.39 for bags, $0.43 for cartons and cans, and $1.09 for carcasses. Thus, using bags as a basis for comparison, it costs 10 percent more per ton to handle cartons and cans, and 179 percent more to handle carcasses.

TABLE 45.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage and loading into highway trucks by use of hand trucks[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor[2] | Total cost | |
| | | | | | | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.258 | [3] 0.506 | 0.439 | 0.07 | 0.64 | 0.71 | 0.82 |
| Cartons.... | .270 | [4] .531 | .463 | .07 | .67 | .74 | .86 |
| Bags....... | .240 | [5] .468 | .401 | .07 | .58 | .65 | .75 |
| Carcasses.. | .584 | [6] 1.158 | .957 | .18 | 1.39 | 1.57 | 1.81 |

[1]Distances standardized at 140 feet from stack to elevator, 48 feet of elevator travel, and 145 feet from elevator to highway truck.
[2]Computed from "current" wage rates.
[3]Bridge plate, 0.079 machine-hour; 3-ton elevator, 0.041 machine-hour; 20 (30- by 66-inch) hand trucks, 0.386 machine-hour; total, 0.506 machine-hour.
[4]Bridge plate, 0.084 machine-hour; 3-ton elevator, 0.042 machine-hour; 20 (30- by 66-inch) hand trucks, 0.405 machine-hour; total, 0.531 machine-hour.
[5]Bridge plate, 0.071 machine-hour; 3-ton elevator, 0.042 machine-hour; 16 (30- by 66-inch) hand trucks, 0.355 machine-hour; total, 0.468 machine-hour.
[6]Bridge plate, 0.170 machine-hour; 3-ton elevator, 0.112 machine-hour; 34 (30- by 66-inch) hand trucks, 0.876 machine-hour; total, 1.158 machine-hours.

**TABLE 46.--Labor and equipment required to move 1 ton of 4 specified package types out of storage and load into a highway truck by use of pallets, semilive skids, jack, and industrial forklift truck[1]**

| Operation element[2] | Workers | 32-pound cans | | | 32-pound cartons | | | 101-pound bags | | | 200-pound carcasses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor | Elapsed time | Equip-ment | Produc-tive labor |
| | *Number* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* | *Hours* | *Machine-hours* | *Man-hours* |
| (a) Break stack, transport to loading spot (300 feet)........................... | 1 | 0.066 | 0.131 | 0.066 | 0.059 | 0.118 | 0.059 | 0.058 | 0.116 | 0.058 | 0.189 | 0.377 | 0.189 |
| (b) Open trailer, prepare to load.......... | 2 | .012 | .012 | .023 | .012 | .012 | .024 | .015 | .015 | .031 | .018 | .018 | .037 |
| (c) Place load on skid inside trailer or on dock at trailer tail gate......... | 1 | .013 | .039 | .013 | .012 | .036 | .012 | .012 | .036 | .012 | .037 | .112 | .037 |
| Handstack pallet: | | | | | | | | | | | | | |
| (d) Inside trailer........................ | 2 | .053 | .212 | .106 | .058 | .231 | .116 | .044 | .176 | .090 | .131 | .525 | .260 |
| (e) On dock at tail gate.................. | 2 | .012 | .024 | .024 | .009 | .018 | .018 | .006 | .012 | .013 | .019 | .038 | .038 |
| (f) Close trailer.......................... | 2 | .003 | .003 | .006 | .003 | .003 | .006 | .004 | .004 | .008 | .005 | .005 | .009 |
| (g) Return empty pallets to stock (150 feet)............................... | 1 | .002 | .004 | .002 | .002 | .004 | .002 | .002 | .004 | .002 | .007 | .014 | .007 |
| Total........................... | | .161 | .425 | .240 | .155 | .442 | .237 | .141 | .363 | .214 | .406 | 1.089 | .577 |

[1] Loading data:
Packages per truckload equivalent: Cans, 1,000; cartons, 1,000; bags, 250, and carcasses, 100.
Total gross weight of packages: Cans, 16 tons; cartons, 16 tons; bags, 12.63 tons, and carcasses, 10 tons.
Unit loads per truckload equivalent: Cans, 19; cartons, 20; bags, 14, and carcasses, 34.
Packages per unit load: Cans, 54; cartons, 50; bags, 18, and carcasses, 3.
Unit load stacking: Cans, 18 by 3 tiers; cartons, 10 by 5 tiers; bags, 3 by 6 tiers, and carcasses, 3 per pallet.
Loads from dock: Cans, 3; cartons, 3; bags, 2, and carcasses, 5.
Loads from inside car: Cans, 16; cartons, 17; bags, 12, and carcasses, 29.
[2] Equipment required: Operation (a) one 3,000-pound industrial forklift truck, one 40- by 48-inch pallet; (b) 1 bridge plate; (c) 1 indusgrial forklift truck, 1 pallet, 1 bridge plate; (d) 1 pallet, one 36- by 60-inch semilive skid and on 3,000-pound capacity jack, 1 bridge plate; (e) 1 pallet, 1 bridge plate; (f) 1 bridge plate; (g) 1 industrial forklift truck, 1 pallet. For a detailed description of the elements composing this operation, see table of element standards in appendix.

TABLE 47.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage and loading into highway trucks by use of pallets, semilive skids, jacks, and an industrial forklift truck[1]

| Type of container | Elapsed time | Labor and equipment required | | Labor and equipment costs | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Total cost | |
| | | Equipment time | Total labor | Equipment | Labor[2] | Current wages | Assumed wages |
| | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Cans....... | 0.161 | [3] 0.425 | 0.240 | 0.08 | 0.35 | 0.43 | 0.50 |
| Cartons.... | .155 | [4] .422 | .237 | .08 | .35 | .43 | .49 |
| Bags....... | .141 | [5] .363 | .214 | .07 | .32 | .39 | .44 |
| Carcasses.. | .406 | [6] 1.089 | .577 | .23 | .86 | 1.09 | 1.23 |

[1]Transportation distances standardized at 300 feet from storage point to highway truck and 150 feet in returning empty pallets to storage.

[2]Computed from "current" wage rates.

[3]Bridge plate, 0.093 machine-hour; 3,000-pound industrial forklift truck, 0.081 machine-hour; 19 (40- by 48-inch) pallets, 0.145 machine-hour; 19 (36- by 60-inch) semilive skids, 0.053 machine-hour; 3,000-pound skid jack, 0.053 machine-hour; total, 0.425 machine-hour.

[4]Bridge plate, 0.093 machine-hour; 3,000-pound industrial forklift truck, 0.073 machine-hour; 20 (40- by 48-inch) pallets, 0.140 machine-hour; 20 (36- by 60-inch) semilive skids, 0.058 machine-hour; 3,000-pound skid jack, 0.058 machine-hour; total, 0.422 machine-hour.

[5]Bridge plate, 0.081 machine-hour; 3,000-pound industrial forklift truck, 0.072 machine-hour; 14 (40- by 48-inch) pallets, 0.112 machine-hour; 14 (36- by 60-inch) semilive skids, 0.044 machine-hour; 3,000-pound skid jack, 0.044 machine hour; total, 0.363 machine-hour.

[6]Bridge plate, 0.211 machine-hour; 3,000-pound industrial forklift truck, 0.234 machine-hour; 34 (40- by 48-inch) pallets, 0.382 machine-hour; 34 (36- by 60-inch) semilive skids, 0.131 machine-hour; 3,000-pound skid jack, 0.131 machine-hour; total, 1.089 machine-hours.

## COMPARISON OF COSTS OF MOVING SELECTED PACKAGE TYPES OUT OF MULTISTORY AND SINGLE-STORY WAREHOUSES AND LOADING INTO RAILROAD CARS AND HIGHWAY TRUCKS

Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage in single-story and multistory warehouses and loading into railroad cars and highway trucks are shown in table 48.

It can be seen that it was more economical to load railroad cars than highway trucks. The principal reason appeared to be that the set-up time for railroad cars was apportioned over a larger tonnage than for highway trucks. The time for opening and closing the highway truck, putting the bridge plate in place, rigging lights in the truck, and related work increased the cost of loading a highway truck or trailer.

### Multistory Warehouses

In multistory warehouses, cans were moved out of storage, transported to the loading position, and loaded into railroad cars by use of hand trucks at a cost of \$0.68 per ton and into highway trucks at a cost of \$0.71 per ton. The difference in elapsed time per ton was approximately 3.4 percent less for railroad cars than for highway trucks for this same container type.

The elapsed time for cartons was found to be 0.006 hour less per ton when loading railroad cars than highway trucks. This time included moving the cartons out of storage,

TABLE 48.--Comparative labor and equipment costs for moving 1 ton of 4 specified package types out of storage in single-story and multistory warehouses and loading into railroad cars and highway trucks by use of specified methods[1]

| Type of package, warehouse, and method | Elapsed time per ton | Labor and equipment required per ton | | Labor and equipment costs per ton | | | |
|---|---|---|---|---|---|---|---|
| | | Equipment time | Total labor | Equipment | Labor | Total cost | |
| | | | | | | Current wages | Assumed wages |
| Cans: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | *Hours* | *Machine-hours* | *Man-hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Hand trucks | 0.249 | 0.532 | 0.420 | 0.07 | 0.61 | 0.68 | 0.78 |
| Pallets, hand trucks, industrial forklift truck | .211 | .684 | .299 | .12 | .43 | .55 | .63 |
| Pallets, hand trucks, walkie-type industrial high-lift truck | .216 | .696 | .308 | .11 | .45 | .56 | .63 |
| Hand truck and walkie-type industrial tractor | .276 | .624 | .448 | .08 | .65 | .73 | .84 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .258 | .506 | .439 | .07 | .64 | .71 | .82 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .171 | .342 | .262 | .08 | .39 | .47 | .53 |
| Pallets, semilive skids, jack, and industrial forklift truck | .152 | .484 | .223 | .09 | .33 | .42 | .45 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .161 | .425 | .240 | .08 | .35 | .43 | .50 |
| Cartons: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Hand trucks | .264 | .566 | .449 | .07 | .65 | .72 | .83 |
| Pallets, hand trucks, industrial forklift truck | .206 | .674 | .300 | .11 | .44 | .55 | .62 |
| Pallets, hand trucks, walkie-type industrial high-lift truck | .211 | .686 | .309 | .10 | .45 | .55 | .62 |
| Hand truck and walkie-type industrial tractor | .291 | .657 | .477 | .08 | .69 | .77 | .89 |
| Hand truck and gravity roller conveyor | .281 | .631 | .484 | .07 | .70 | .77 | .89 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .270 | .531 | .463 | .07 | .67 | .74 | .86 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .173 | .342 | .273 | .08 | .40 | .48 | .55 |
| Pallets, semilive skids, jack, and industrial forklift truck | .152 | .502 | .231 | .08 | .34 | .42 | .48 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .155 | .422 | .237 | .08 | .35 | .43 | .49 |
| Bags: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Hand trucks | .233 | .454 | .390 | .07 | .56 | .63 | .73 |
| Pallets, hand trucks, industrial forklift truck | .234 | .655 | .325 | .12 | .47 | .59 | .67 |
| Pallets, hand trucks, walkie-type industrial high-lift truck | .240 | .676 | .338 | .12 | .49 | .61 | .70 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .240 | .468 | .401 | .07 | .58 | .65 | .75 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .141 | .279 | .207 | .07 | .31 | .38 | .43 |
| Pallets, semilive skids, jack, and industrial forklift truck | .152 | .401 | .225 | .08 | .33 | .41 | .47 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .141 | .363 | .214 | .07 | .32 | .39 | .44 |
| Carcasses: | | | | | | | |
| Multistory warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Hand trucks | .571 | 1.132 | .935 | .18 | 1.36 | 1.54 | 1.77 |
| Shipped by highway truck: | | | | | | | |
| Hand trucks | .584 | 1.158 | .957 | .18 | 1.39 | 1.57 | 1.81 |
| Single-story warehouse: | | | | | | | |
| Shipped by railroad car: | | | | | | | |
| Pallets and industrial forklift truck | .383 | .780 | .539 | .22 | .80 | 1.02 | 1.16 |
| Shipped by highway truck: | | | | | | | |
| Pallets, semilive skids, jack, and industrial forklift truck | .406 | 1.089 | .577 | .23 | .86 | 1.09 | 1.23 |

[1] Transportation distances were standardized at 140 feet from stacking point to elevator, 48 feet elevator transport, and 145 feet from elevator to railroad car or highway truck in multistory warehouses. In single-story warehouses, transportation distances were standardized at 300 feet from storage point to railroad car or highway truck, and 150 feet in returning empty pallets to storage. These data do not include the costs of management or facilities, for example, cost of the land, building, engine room, or other overhead costs.

transporting to the loading platform, and loading into the carrier. As noted above, the set-up time influenced the total elapsed time because it was spread over fewer elapsed hours when highway trucks were loaded. However, since there was less room in a highway truck than in a railroad car, there was some evidence that loading at the work face in a railroad car was somewhat easier. Thus, cartons were handled 2.2 percent faster when railroad cars were the carriers, and this represented a saving of $0.02 per ton or 3 percent. Bags were handled 3 percent faster into railroad cars at a saving of $0.02 or 3 percent per ton.

Highway truck shipments of animal carcasses required 2 percent more hours per ton than those in cars, at an added cost of $0.03 or 2 percent per ton. The difference between carriers in elapsed time and in total costs was less for carcasses than for the other container types.

## Single-Story Warehouses

In single-story warehouses, when highway truck and railroad car shipments were compared for moving out of storage and placing into a carrier, it was found that bags could be handled faster for truck shipment, and cans and cartons were handled faster for car shipment. Speed of handling is an important factor in computing costs for the various container types.

Cans were handled 6 percent faster when loaded into a railroad car than when loaded into a highway truck, and this cost $0.01 less per ton. Cartons were handled 2 percent faster and at a saving of $0.01. Bags reversed the direction of savings, for they were handled 7 percent faster when loaded into a highway truck, at a saving of $0.02 per ton, or 5 percent, compared with loading into railroad cars. No railroad car shipments of carcasses were observed, so no comparison of carcass handling could be made for this method.

## Comparison of Costs by Package Type

Comparisons of various handling methods used to move merchandise out of storage in multistory and single-story warehouses, transport it to the loading dock, and load it into railroad cars and highway trucks are shown in table 48.

The costs shown in table 48 are based on direct labor and equipment costs only, and do not reflect other costs, such as those for land, buildings, engine room operation, and other items.

Cans.--In loading out cans in the single-story warehouse, the method using pallets, semilive skids, jacks, and an industrial forklift truck showed the lowest total elapsed time per ton and total cost per ton. The elapsed time for this handling method for cans shipped by railroad cars was 0.152 hour per ton, at a cost of $0.42. All 3 handling methods observed in the single-story warehouse for loading into railroad cars and highway trucks produced elapsed times and costs of handling that were lower than the most efficient multistory handling systems observed.

Of the methods in multistory warehouses for removing cans from storage and loading into a railroad car, use of pallets, hand trucks, and an industrial forklift truck gave the most efficient results, at 0.211 hour per ton and a cost of $0.55 per ton. This was about 39 percent slower than the best single-story warehouse handling system for cans. The cost of this handling system was $0.13, or about 31 percent, more per ton than for the best single-story system observed.

The next best multistory warehouse operation observed for moving out of storage and loading into a railroad car followed closely the best multistory system, at 0.216 hour per ton and a cost of $0.56 per ton. This is 2.4 percent slower and 1.8 percent per ton more costly than the best multistory system, and 42 percent slower and 34 percent more expensive than the best single-story warehouse system.

When the hand-truck systems alone were compared in multistory warehouse operations, it was found that cans were handled 3.6 percent faster when loading railroad cars than when loading highway trucks, and that it cost 4.4 percent, or $0.03, more per ton to load the highway trucks.

In the single-story warehouse, it was found that cans were loaded into railroad cars 5.9 percent faster and at $0.01, or 2.3 percent, less cost per ton than when loaded into highway trucks using pallets, semilive skids, jacks, and an industrial forklift truck. The chief reason seems to be that the time for opening and closing the car is distributed over a greater tonnage.

The least efficient handling method observed, from the standpoint of elapsed time and costs involved, was that of the multistory warehouse system using hand trucks and walkie-type industrial tractors. This method cost $0. 73 per ton, which was $0. 18 per ton higher than the most efficient pallet and forklift system in multistory warehouses. This operation, also, took 31 percent more time per ton than the best multistory operation.

Cartons. --The best times for handling cartons occurred in the single-story warehouse when pallets were loaded on semilive skids, jacks were used to place the skids in railroad cars, and an industrial forklift truck was used. This method gave elapsed times of 0. 152 hour per ton when cartons were loaded into railroad cars and 0. 155 hour when they were loaded into highway trucks. The costs and elapsed times of this operation were about the same for trucks and railroad cars. The total costs were $0. 42 per ton for railroad cars and $0. 43 for trucks.

When the best carton-handling operations were observed in multistory warehouses, it was found, again, as in handling cans, that the method whereby pallets are placed on hand trucks for transport, but are removed from stacks by an industrial forklift truck, gave the best times observed and cost less than other methods. When an industrial forklift truck was used in this system, elapsed times of 0. 206 hour per ton were recorded. When a walkie-type industrial high-lift truck was used, the elapsed time per ton was slightly higher, or 0. 211 hour per ton.

It was found that the best multistory warehouse system required 35 percent more time and cost $0. 13, or 30 percent, more per ton than the best single-story handling method.

The least efficient method of handling cartons in multistory warehouses was that using the hand truck towed by the walkie-type industrial tractor. This method required an elapsed time of 0. 291 hour per ton at a cost of $0. 77. The method also was 41. 0 percent slower than the best multistory warehouse operation, and its total cost per ton was $0. 22 greater. Use of a gravity roller conveyor and hand trucks also cost $0. 77 per ton, but was somewhat faster.

It cost almost 2 cents a ton more to move cartons out of storage with hand trucks and load them into a highway truck than to load the same tonnage into a railroad car. The elapsed times were 0. 264 hour for cars and 0. 270 hour for trucks, a difference of 2. 2 percent.

Bags. --Introduction of mechanized equipment or palletization in bag handling did not prove advantageous in the multistory warehouses observed in this study; on the other hand, in the single-story warehouse, the elapsed time of 0. 141 hour per ton was recorded for 2 somewhat different palletized systems. Total costs of labor and equipment in the single-story warehouse operation were $0. 38 per ton when pallets and an industrial forklift truck were used. When pallets, semilive skids, jack, and an industrial forklift were used, the costs were slightly greater, by almost 1 cent per ton.

In the multistory warehouse, bags were handled in about the same time when a forklift truck was used to remove pallets from the storage room stacks and place them on hand trucks, as when hand trucks alone were used. Elapsed times for these operations were 0. 234 hour and 0. 233 hour per ton, respectively. However, it was $0. 04 per ton more economical to use the forklift to remove the bags from the storage room stacks, because less labor time was required in the operation.

The best single-story handling system observed was 65 percent faster than the best multistory method and reflected a difference in costs of $0.21 per ton, or 55 percent.

When hand-truck methods were compared for multistory warehouse operations, it was found that it cost $0.02 more per ton to load highway trucks than railroad cars, based on current wages.

Carcasses.--In comparing hand-truck methods of handling carcasses in multistory warehouses, it was found that carcasses are moved out of storage, transported to the loading platform, and hung in railroad cars at a cost of $0.03 per ton less, and 0.013 hour per ton faster, than they could be loaded into highway trucks. The total costs of this operation in multistory warehouses were $1.54 per ton when loading railroad cars and $1.57 per ton when loading highway trucks.

Single-story warehouses had far better results. When pallets and an industrial forklift truck were used and a railroad car was loaded, the elapsed time was 0.383 hour per ton at a cost of $1.02. A modification of this system, wherein a pallet, semilive skid, jack, and industrial forklift truck were used to load a highway truck, showed an elapsed time of 0.406 hour per ton and cost $1.09 per ton.

Comparing the 2 methods, it was found that the semilive skid and jack variation together with the highway truck carrier gave a 6 percent slower operation at a cost 6.9 percent higher per ton, due chiefly to the use of the semilive skid and jack combination.

## COMPARISON OF COMBINATIONS OF TYPES OF MATERIALS HANDLING EQUIPMENT USED FOR MOVING COMMODITIES INTO, WITHIN, AND OUT OF REFRIGERATED WAREHOUSES

Table 49 shows total costs for labor and equipment for handling 1 ton of 4 specified package types into, within, and out of single-story and multistory warehouses by use of specified types of equipment. These costs include the labor and equipment, but not other

TABLE 49.--Total costs for labor and equipment for handling 1 ton of 4 specified package types into, within, and out of single-story and multistory warehouses by use of specified types of equipment[1]

| Type of warehouse, carrier, and equipment | Total costs-current wages[2] | | | | Total costs-assumed wages[3] | | | |
|---|---|---|---|---|---|---|---|---|
| | Cans | Cartons | Bags | Carcasses | Cans | Cartons | Bags | Carcasses |
| Multistory warehouses[4] | | | | | | | | |
| Railroad cars: | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Hand trucks | 1.54 | 1.66 | 1.39 | 3.21 | 1.78 | 1.92 | 1.61 | 3.70 |
| Pallets, hand trucks, and industrial forklift truck | 1.30 | 1.33 | 1.35 | -- | 1.49 | 1.51 | 1.53 | -- |
| Pallets, hand trucks, and walkie-type industrial high-lift trucks | 1.34 | 1.35 | 1.39 | -- | 1.53 | 1.53 | 1.59 | -- |
| Hand trucks and walkie-type industrial tractors | 1.62 | 1.73 | -- | -- | 1.87 | 2.00 | -- | -- |
| Hand trucks and gravity roller conveyor | -- | 1.74 | -- | -- | -- | 2.02 | -- | -- |
| Highway trucks: | | | | | | | | |
| Hand trucks | 1.60 | 1.70 | 1.45 | 3.29 | 1.86 | 1.97 | 1.69 | 3.80 |
| Single-story warehouses: | | | | | | | | |
| Railroad cars: | | | | | | | | |
| Pallets and industrial forklift truck | 1.08 | 1.23 | .88 | 2.18 | 1.22 | 1.42 | 1.01 | 2.47 |
| Pallets, semilive skids, jacks, and industrial forklift trucks | 1.04 | 1.07 | .95 | -- | 1.19 | 1.22 | 1.09 | -- |
| Highway trucks: | | | | | | | | |
| Pallets, semilive skids, jacks, and industrial forklift trucks | 1.10 | 1.08 | .92 | 2.39 | 1.26 | 1.23 | 1.04 | 2.70 |

[1] Transportation distances were standardized at 145 feet from railroad car or highway truck to elevator, 48 feet elevator transport, and 140 feet from elevator to stacking point for multistory warehouses. In single-story warehouses, transportation distances were standardized at 300 feet from railroad car or highway truck to temporary storage and lot stamp, and 300 feet from temporary storage to stacking point in the cold storage rooms.
[2] "Current" hourly wage rates were assumed to be for unskilled, $1.45; semiskilled, $1.55, and skilled, $1.65.
[3] "Assumed" hourly wage rates were assumed to be for unskilled, $1.70; semiskilled, $1.80, and skilled, $1.90.
[4] Costs shown for multistory warehouse include costs for elevators.

costs such as those for buildings, building maintenance, land, taxes on facilities, and operation of refrigeration equipment.

## Multistory Warehouses

The method using pallets, hand trucks, elevators, and industrial forklift trucks was the most efficient in multistory warehouses. This method combined the maneuverability of hand trucks on elevators and through hand-operated vestibule and storage room doors with the lower cost of unit load stacking and destacking when forklift trucks were used (fig. 30).

Neg. BN-3692

Figure 30.--Freezer room door showing manually operated spring latch.

Pallets, hand trucks, elevators, and walkie-type industrial high-lift trucks showed slightly higher costs. This method also combined the maneuverability of the hand trucks with the lower cost of unit load stacking by the forklift trucks. The initial cost of the walkie-type industrial high-lift truck was lower than for the riding-type truck, and its cost of ownership and operation also was lower. The travel and stacking speed of the walkie-type truck was slower than for the riding-type truck. An extra man was required to maneuver the hand trucks during the tiering operations with both types of forklift trucks.

Hand trucks and elevators formed a relatively costly combination from the standpoint of total cost per ton. The hand trucks appeared to be more maneuverable and were operated at slightly higher speed than walkie-type industrial high-lift trucks or tractors. One decided advantage of hand trucks was that aisle widths could be narrower than when power stacking equipment was used. The narrower aisles increase the percentage of utilization of warehouse space.

Handstacking is necessary in the initial unloading and final loading of the carrier. With the low ceilings and close column spacing prevalent in multistory warehouses (figs. 31, 32, and 33), a higher utilization of room volume can be secured with the narrower aisles and by handstacking to the maximum permissible height. Stacking above 7 feet high can be done by workers using temporary platforms, but this adds to the cost per ton. This may prove to be more economical, however, for the warehouses with regard to percentage of occupancy and average length of storage time of lots handled.

Use of hand trucks towed by walkie-type industrial tractors, with elevators, was one of the highest cost methods. Although it was possible to tow heavier loads with the tractor, this advantage was offset by the slow rate of operation.

The method utilizing hand trucks, gravity roller conveyor, and elevator was not used for handling cans, bags, or carcasses, and had only a limited application in the selected warehouses for handling cartons. The method required double handling of each package during the unloading and loading operations--one handling to place the containers on the conveyor and another to remove them.

## Single-Story Warehouse

Use of pallets, pallet dollies or semilive skids, and industrial forklift trucks in single-story warehouses developed the lowest total cost per ton of all methods studied. Much of the difference between this and other methods consisted of the cost of ownership and operation of the elevator. The method discussed herein produced the best results if the storage room doors could be opened and closed without stopping the forklift truck and having the operator dismount, as is possible with bump-operated storage room doors. If this cannot be done, the truck operator must stop the truck, dismount, open the storage room door, remount the truck, drive through the door, again stop the truck, dismount, close the door, remount, and continue his operation. However, by mounting door-operating mechanisms on the outside face of freezer room doors, it is possible to overcome this disadvantage. In addition, bump-operated doors are practical and require little maintenance.

Neg. BN-3693

Figure 31.--Heavy, closely spaced columns usually found in multistory warehouse storage rooms.

Neg. BN-3694

Figure 32.--Low ceiling in a typical multistory warehouse storage room, showing air ducts over aisles.

Neg. BN-3695
Figure 33.--Low ceiling in a typical multistory warehouse storage room, showing brine pipes crossing over the aisle.

The method using only pallets and industrial forklift trucks is somewhat less effective than the method just discussed. The reason is that all the inbound containers must be carried from the work face to the pallet, and outbound containers from the pallet to the work face. Consequently, it should not be used for small containers that would necessitate a large number of walking trips; instead, a pallet dolly or semilive skid and jack should be used to move the pallet inside the car or truck.

## RECOMMENDATIONS AND CONCLUSIONS

Because over 75 percent of all work in a public refrigerated warehouse, whether multistory or single-story, is performed in materials-handling operations, materials handling is a major problem, especially with high labor costs.

In the last decade, many new types of materials-handling equipment have been developed. Therefore, management should review the methods and equipment currently available and select the proper equipment for the particular handling needs. Before this can be done, however, a complete survey must be made of buildings, types of merchandise handled, and costs of handling with the methods presently employed.

## Operating Practices

When equipment has been chosen to fit the building and the specifications of the handling situation, it is still necessary to develop procedures to a fine point in order to eliminate wasted effort and other inefficiencies. Improperly used equipment can be high-priced in terms of costs and employee morale. Therefore, operations should be timed and balanced to ascertain where and how the new equipment may be used most effectively. The element standards in the appendix of this report may be used where necessary to help in equipment selection, in preparing operation procedures for proposed methods, and in comparing proposed methods and combinations of equipment with those currently used. Procedures should be written to cover every commonly used warehouse operation and to standardize operations.

Multistory warehouse operators cannot achieve the same tonnage per man-hour as a single-story warehouse operator. However, they cannot afford to overlook the possibilities of streamlining their operations.

### UTILIZATION OF SPACE

Unless the clearance between ceiling and floor is great enough (14 feet, 6 inches) to permit stacking of unit loads 3 pallets high, the utilization factor will not be improved, but instead may be reduced by the introduction of palletization. This is because hand-stacking can be done from 5-foot aisles while mechanized stacking requires 7-foot aisles as a minimum. In other words, it would require the volume of storage represented by a third tier of pallets to offset the area lost by the wider aisles.

### APPLICATION OF MECHANICAL EQUIPMENT

Whether or not mechanical handling methods are to be introduced to replace manual handling will depend on the interrelationship of several factors. The most obvious one is the length of time the particular shipment is destined to remain in storage. If the period is short, then the containers should remain on the pallets to facilitate quick removal. The resulting saving in labor will tend to offset the losses in rental revenue from the decreased space utilization.

It is unlikely that a warehouse will find it desirable to handle all of its storage items by one single method, for example, all palletized or all handstacked. Barrels or bales can be stacked to a desired height without being palletized, and irregular shaped parcels such as hams are best handled in wire or wooden crates that can be piled one on top of the other.

### SPEED OF OPERATION

In practically all warehousing operations, the necessary labor should be used as a group working together, so that, in determining the organization for any method, the minimum number of men is specified. When it is necessary to reduce the elapsed time to accomplish a given task, it is customary to employ additional handlers for loading or unloading the railroad car or truck. As a general rule, it 2 men are used to perform a 1-man job, or 4 men to perform a 2-man job, the elapsed time for completion will be reduced by roughly 40 percent and the total cost will be increased 20 percent.

### LAYOUT AND DESIGN OF STORAGE FACILITIES

The study of the 6 selected locations in particular and of refrigerated warehouses in general has indicated certain defects in the design of existing structures or their installed facilities. The extent by which such defects can be eliminated or mitigated will determine how successful the introduction of modern materials-handling equipment will be. It was concluded that:

1. If the warehouse is a multistory structure, then elevators are a necessity, and they should be located as centrally as possible to minimize the horizontal distances

to be traveled. Elevator speed should be at least 150 feet per minute, with self-leveling features. The capacity should be not less than 3 tons, and doors should be of overhead lift type, opening across the entire car width.

2. It is probable that any mechanized materials-handling program will be limited in many details to the controlling factors established by the vertical transportation. Elevators should be located to permit entry from opposite sides. A car permitting loads carried side-by-side, rather than end-to-end, is much preferred, since a load can be removed at any floor without disturbing the others. Automatic controls should be provided where possible.

3. The elevator car should have not more than a 1-inch gap between its floor and the floor of the building if modern materials-handling equipment is to be used. If the space exceeds this, it is likely that it will be necessary to install a movable sill, or place a bridge plate each time a pallet-handling truck, with wheels under 6 inches in diameter, moves in or out of the elevator.

4. Unlike other warehouses that store merchandise at normal temperatures, a refrigerated warehouse must contain a number of segregated and insulated areas in which different temperatures and humidities are maintained. The necessity for numerous doors in a multistory warehouse is apparent, but the condition does slow up the motion of trucks passing to storage areas. Doorways should be a minimum of 6 feet and 6 inches high by 6 feet and 8 inches wide, to accommodate platform hand trucks; and 7 feet wide for mechanical equipment. Presumably the doors will be hinged on the side. If provided with an automatic opening arrangement with push button or pull cord control that can be activated by an operator without dismounting from his truck, the time saved in transportation becomes worthwhile. In many warehouses, air locks are used. These are formed by a vestibule, so that two sets of doors must be passed through. Recently, a new development has been noted that might be applicable to such an arrangement. This consists of a heavy sheet-rubber blanket, so hung that it is pushed open by a vehicle and swings shut after the vehicle has passed. In addition, bump-operated doors also offer definite advantages and are used in many of the newer warehouses.

5. Moisture dripping from brine lines will cause slipping that will deprive power trucks of traction. Sanding may temporarily correct this, but it is best to exert every effort to keep the accumulation of water at a minimum.

6. One way to eliminate excessive moisture was observed. In a large receiving and shipping room, a trough leading to the sewer was hung below a bank of coils. Fans were placed to blow on these coils, drawing air through the doorways so that excessive moisture condensed on the coils. The arrangement kept the floor relatively dry in spite of the large tonnage of frozen products handled.

7. Floors should be smooth and without ramps or thresholds, if possible. If ramps must be used to climb from one level to another, they should be kept at as low a slope as possible. A 6-percent grade is considered reasonable and 10 percent is about the upper limit. For an industrial truck to go up a 10-percent grade of 20-foot length requires an extra 16.1 watt-hours per ton in excess of the current consumption needed to move the same load a distance of 130 feet on a level course. The start and end of the ramp must not be too sharp, or low-slung vehicles will be hung up and loads may be displaced by the lack of stability. Both ramps and bridge plates should be approached straight on, for the combination of turning and rising at the same time places an abnormal power demand on the battery of an electric industrial truck.

8. Columns should be spaced to permit the most efficient set-off of palletized loads and, whenever possible, room walls should be located on column center lines to minimize lost space.

9. Ceiling heights determine the ability to store vertically. Hand-stacking indicates a clearance requirement of 9 feet from floor to ceiling or below suspended coils; 2-high pallets, each 4 feet and 6 inches overall, require 10 feet of clearance, and 3-high pallets take a clearance of 14 feet, 6 inches.

10. Corridors should be 12 feet between walls to permit 2-way passage of handling equipment, and within the rooms the aisles should be 5 feet wide for hand truck usage, 7 feet minimum width for use of straddle-type lift trucks, and 12 feet wide if counterbalanced industrial forklift trucks are to stack at right angles to the aisles.

11. Spotting railroad cars can be made more effective if a car puller is used.

12. Truck and railroad car platforms should be at least 15 feet wide. Car rails should be so placed that the side-hinged refrigerator car doors will open over the platform or there should be at least 30 inches between the edge of the railroad car platform and the car side. It is recommended that there be a minimum of 8 feet from the center line of the track to the platform edge.

13. Due to the lack of standardization of truck or railroad car floor heights, it is difficult to state exactly what the platform heights above the road or track level should be. The recommended truck platform height is 50 inches, or the height of the particular truck fleet, with ground level graded so that lower truck bed heights may be accommodated.

A platform height of 4 feet and 6 inches above the rails will bring the floor of most refrigerator cars to an equivalent level. Most cars have doorways 4 feet wide and 6 feet and 4 inches high, although a door opening as small as 2 feet and 8 inches by 5 feet and 4 inches still is prevalent in old equipment. The dimensions given are measured from the floor. The floor racks decrease the height of the opening by at least 4 inches, so it is improbable that many car doors will be encountered which exceed 6 feet in clear height.

## EQUIPMENT DEFECTS

The defects noted in materials-handling equipment are somewhat easier to correct. For example:

1. Rubber tires on hand trucks are undesirable. The wheels have a tendency to freeze to the floor if left in a cold location.

2. Hand trucks should be only heavy enough to be substantial. The difference between a 300-pound and a 600-pound hand truck carrying a pay load of 800 pounds may mean the need of an additional man to push it.

3. Gasoline vehicles are undesirable in tightly enclosed areas. The exhaust fumes are noxious and dangerous to personnel and may be absorbed by certain foods, such as dairy products and eggs.

## Other Efficiency Factors

The costs of handling can be held down by placing as many containers on each load as possible. This number will vary with the dimensions and weight of the particular containers, differences in the height of the car racks and the platform, condition of floors, and type of equipment used. When the dimensions of the containers do not permit good binding of the loads by using alternate container patterns in the layers, the top tier of the loads should be bound with a cord or wire tie to prevent the containers from being jolted off the truck or pallet. This is especially true of such containers as cases of eggs and cans. Tie binding in this manner was observed in only a few cases during the study.[9]

[9] Several companies are now selling precut tie ropes with patented easy-tying fastening devices attached. Quite a few of the warehouses in the industry that make extensive use of tie ropes use sash cord, or sisal hemp rope, cut to the proper length. The ends are knotted to prevent raveling.

Cardboard sheets inserted between the layers of a load were used in one of the selected warehouses to bind the loads.

Maintaining an adequate supply of equipment reduces delays. Waiting for hand trucks was one of the major causes of delay observed during the study.

Operators should use a minimum number of workers in the unloading and loading operations. Extra workers increase the cost of these operations. This is especially true in the opening and closing of cars. There is never room at the door of the car for more than 2 workers to remove the first packages broken out of a carload; additional men, attempting to work in the confined space at that time, are not able to perform any useful work and usually retard the effort. After sufficient space has been opened in a car, 2 groups can operate efficiently, but at slightly higher cost due to some additional delays caused by crew interference. If a 4-man crew is to unload a car when there is more than 1 car at the dock, the second crew should be opening other cars. When the first crew has cleared enough space in the car for both crews to work, then the two crews join efforts. When the first car is almost empty, one crew leaves the car and clears a workspace in the next car, and so forth.

In operations which involve placing pallets on hand trucks, an adequate supply of hand trucks and pallets is essential. Pallets should be loaded with a maximum number of containers consistent with safety, the pallet loads bound with ties when necessary, and a minimum of personnel should be used in the unloading and loading-out operations consistent with the required rapidity of the operation.

It is possible to eliminate some maneuvering of hand trucks during the stacking operation in the storage rooms if the trucks have brakes to hold them in position when the forklift truck removes the pallets. If space is available so that the loads can be placed by the worker in the proper position for removing the pallets, no further maneuvering is required during the stacking operation. The use of straddle-type forklift trucks was recommended for several of the warehouses in the study. This truck can operate in 7-foot aisles instead of the 12-foot aisles required for the counterbalanced forklift truck; therefore, a cost advantage would be obtained by using the space made available by a smaller aisle.

When speed is the primary objective, the number of men in the handling crews can be increased, although with a commensurate increase in cost per ton (see page 97, Speed of Operation).

When elevators are used, the transport time can be decreased by using an additional worker to assist the elevator operator in pushing loads on and off the elevators. This is done in warehouses that have elevator cars large enough to carry 4 or more trucks at a time. Increasing the rapidity of elevator operation in this fashion usually increases costs. Where lower ceiling heights are encountered and pallets are stacked 2 high in the storage rooms, increasing the height of the load to 2 pallets will also increase the percentage of space utilized in the storage rooms.

The best pallet loading patterns for the particular containers handled in the warehouse should be worked out in advance. The pallets should then be loaded according to the predetermined patterns, rather than permitting the workers to use their own judgment in individual applications. Pallet loading patterns have been worked out for a large variety of containers for standard pallets of several sizes by a private company, under the title "The Palletizer."[10] These charts can be used as a guide for setting up standard procedures for loading pallets.

Since floor racks in refrigerated cars normally preclude the use of a forklift truck within the car itself, the unloading and loading operations can be hastened, with less worker fatigue, if pallet dollies are used. The pallets are placed on the dolly and moved

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[10] "The Palletizer," Modern Materials Handling, 795 Boylston Street, Boston 16, Mass.

manually to the work face where individual packages can be taken off or placed on the pallet. Comparable handling efficiency may be obtained by use of semilive skids and jacks.

## Equipment

### ELEVATORS

Elevators are generally fixed in the warehouses, so that only in exceptional cases is it feasible to attempt to change the size or capacity of existing equipment. Any such change usually involves major expenditures. In general, minimum elevator capacity of 6,000 pounds is desirable, with car sizes permitting loads side by side rather than end to end, since any load can then be removed at any floor without disturbing the other loads. Elevators should have a speed of 150 to 200 feet per minute, self-leveling features, if possible, and counterbalanced doors.

When changes in elevators are contemplated, the engineering staffs of reputable elevator manufacturers should be consulted, since changes in this equipment require the best advice obtainable.

### FORKLIFT TRUCKS

In selecting forklift trucks, it is necessary to determine whether the trucks are to be used for transporting, stacking, and breaking out pallet loads in single-story or multistory warehouses. Either the counterbalanced or the straddle-type industrial forklift truck can be used for both transportation and stacking. The walkie-type industrial high-lift trucks are most useful for the stacking operations only. Their slow travel makes them less desirable for moving pallets from place to place. Widths and types of doors and passageways inside the warehouse must be considered, so that a forklift truck is selected that can readily operate inside the warehouse. The type of pallets to be handled must also be considered. If straddle-type trucks are to be used with standard pallets, the outriggers of the forklift trucks may add approximately 8 inches to the floor space requirements of each pallet load. This extra space must be taken into consideration when determining the kind of equipment to be purchased.

### PLATFORM HAND TRUCKS

Platform hand trucks are used chiefly in multistory warehouses, where they provide a means of adapting operations to a palletized system; they can be used, with pallets, to take advantage of the reduction of labor by stacking and breaking stack with lift trucks. Each load is mobile in itself, and does not require other equipment for loading and unloading the elevators. When hand trucks are used with pallets and straddle-type forklift trucks, the wheel spacing of the hand trucks becomes important. This is because it is necessary to provide space for the outriggers of the forklift truck to go between the truck wheels without placing the center of gravity of the load so far off the center of gravity of the truck that the loads will be unstable when negotiating bridge plates or ramps in the warehouse. This is not a limitation when counterbalance-type forklift trucks are used.

In the selected warehouses, the number of hand trucks required was determined by dividing the tonnage handled by the capacity of the hand trucks in tons per hour. Because the hand trucks were used for "banks" between the docks and the elevators, in the elevator vestibules, and for temporary storage of lots to be shipped, it was necessary to multiply the number of trucks, determined in the above manner, by 4 to determine the actual number required.

All of the factors mentioned--the method of handling the trucks, the number of floors in the warehouse, the elevator capacity and speed, and the horizontal distance to be traveled--must be considered in determining the number of hand trucks required.

## WALKIE-TYPE INDUSTRIAL TRACTORS

Walkie-type industrial tractors were used in only 1 of the selected warehouses. In this case, the average towing distance between docks and elevators was 145 feet and only one hand truckload was towed at a time. This equipment proved difficult to maneuver because of the combined length of the tow truck and the load, and it operated at slower-than-walking speeds. Its advantage lies in the fact that one man can tow heavy loads with the tractor.

## PALLETS

Several factors affect the selection of pallets. They should be large enough to carry maximum pay loads and should be narrow enough to pass through the doors of refrigerator cars. In the selected warehouses, pallets 36 inches wide by 48 inches long, and 40 inches wide by 48 inches long proved to be most advantageous. In 1 of the selected warehouses, the sizes were modified to 40 inches by 40 inches because of the column spacing in the warehouse. In another, 48-inch by 48-inch pallets could be used where incoming commodities were handled from boxcars only and the width of the pallet was not influenced by the width of the car doors.

The number of pallets required in any warehouse must be determined from actual layouts of the net piling space, percentage of occupancy, volume of operations, and other factors.

## Physical Structure

Various defects in the layout and design of the warehouse buildings, as they affect materials handling, were noted in the selected warehouses and are considered to be typical of the industry, especially in the older buildings. Among these are: (1) Narrow platforms, which prevented easy manipulation of loads and handling equipment; (2) low platforms as compared with the rack heights in refrigerated cars, which presented obstacles to the easy passage of loads and equipment between platform and railroad car or highway truck; (3) narrow and low doors and passageways, which restricted the sizes of loads and handling equipment that could be used; (4) heavy and closely spaced building columns, which restricted the lengths, widths, and numbers of unit loads that could be placed in the storage rooms, and thus reduced the percentage of occupancy when a palletization system was used; (5) low ceilings, which restricted the height of stacking and reduced the revenue potential; (6) low-hanging cooling coils, which limited the stacking heights; and (7) small, slow elevators of inadequate capacity, which increased the handling costs.

In some cases, it is possible to correct these conditions; for example, by widening or raising the platforms, by relocating or replacing the cooling coils with other types of cooling equipment, or by increasing the elevator speeds. However, it is very unlikely that any of the last-mentioned defects can be rectified except at prohibitive expense, although it may be possible in some instances to improvise in order to obtain better operating conditions.

For example, it may be possible to correct low platforms by excavating or grading adjacent ground so that the platform will be suitable for highway trucks of varying heights. Automatic, or floating, docks can also be installed if capital improvement funds are available for this purpose. It is possible to build up the existing platform with a concrete or wooden structure.

# APPENDIX

## How to Use Elemental Data to Build Synthetic Standard Time Values for Combinations of Equipment

In this study, time-study techniques were used which permitted the development of standard time values for performing each of the various materials-handling operations.

Thus, standard time values for appropriate operations can be regrouped or synthesized for a cycle of operations which includes similar operations from several other cycles.

As an example, a standard time for handstacking on a hand truck for specific commodity weights was established, and standard times for various transportation distances were compiled. Therefore, the total time required to handle a commodity with hand trucks through a given cycle of operations can be calculated regardless of transportation distance.

When combining various types of equipment, an important factor is whether one type of equipment can handle various container types in the same elapsed time as another type. Generally speaking, in most locations where labor rates are high, the equipment combination requiring the largest labor time is the most costly; therefore, it is essential that warehouse operators obtain the fullest measure of efficiency from their equipment. This can be done by comparing plant operations with the operations and equipment combinations compiled in this study.

In the studies, seven practical combinations of equipment now being used in the industry for operations concerned with moving commodities into, within, and out of storage were examined and compared. Standard times for the elements composing the operations described in the text, and for related operations, may be found in the table of element standards beginning on page 91.

## Standard Data

Tables 50 to 85 contain a description of most of the operations found in materials-handling methods used in public refrigerated warehouses. These data may be used to develop synthetic time values which permit the evaluation of combinations of handling equipment that were not discussed in the body of this report. It also is possible for individual plant operators to use these data to compare their present methods with other methods and equipment. In these standards an allowance of 5 percent was made to cover personal needs for all operations except work in freezers. An additional 5 percent was included for operations in which it was necessary to enter the freezer rooms. Fatigue allowances were based upon allowances which would normally be used for the cold storage warehouse working environment.

The tables cover time values for the operation descriptions as follows:

| Table No. | |
|---|---|
| 50 | Open and close railroad cars |
| 51 | Stamp lot numbers |
| 52 | Check weights |
| 53 | Open and close highway trucks |
| 54 | Miscellaneous elements |
| 55 | Unload railroad cars and highway trucks |
| 56 | Handstack barrels and other noncubical rigid containers |
| 57 | Handstack cartons, crates, or boxes |
| 58 | Handstack bags, bales, and nonrigid containers |
| 59 | Handstack irregular items |
| 60 | Handstack on pallets, miscellaneous elements |
| 61 | Transport loads on dead skids, miscellaneous elements |
| 62 | Handling beef or horse hinds on special racks |
| 63 | Transport loads on hand trucks, miscellaneous elements |
| 64 | Walk to hand truck |
| 65 | Push empty hand truck |
| 66 | Push loaded hand truck |
| 67 | Transport pallets on industrial forklift truck, miscellaneous elements |
| 68 | Travel empty or loaded, electric industrial forklift truck |
| 69 | Low-lift trucks, miscellaneous elements |

TABLE 50.--Average labor requirements per occurrence for opening and closing railroad cars and railroad refrigerator cars, and other set-up and clean-up operations

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| Open refrigerator cars: Begins when workers travel to railroad car to break the seals, 100 feet approximately. Includes opening the car doors, recording opening temperature, securing and rigging bridge plate, rigging lights in car, recording loading data on tally sheet, removing blocking, and rigging curtain door. Does not include removal of heavy, nailed-in bracing, or bulkheads, or securing or removing empty pallets. Ends when the first container can be removed from loaded railroad cars or the first container can be loaded into empty cars | *Number* 2 | *Man-minutes* 11.77 | *Percent* 5 | *Percent* 5 | *Man-minutes* 12.95 |
| Close refrigerator cars: Begins when the last loaded or empty hand truck has been pushed clear of the car door, or the last loaded or empty pallet has been removed from the car door. Includes checking tally sheet, removing curtain, removing lights, removing bridge plate, closing and latching car door, attaching and recording car seals. Ends when the doors of empty cars have been closed, or the seals have been attached to the doors of loaded cars. Does not include placing of bulkheads or heavy, nailed-in bracing, or removing empty pallets from the dock area | 2 | 7.20 | 5 | 5 | 7.92 |
| Place paper in car: Elements required to staple a single thickness of 48-inch-wide roll paper to the sides, ends, and floor of a rail car, covering approximately half the height of the car. Begins when the workers start the travel to secure paper and tools (approximately 50 feet) and ends when the surplus paper and the tools have been replaced in storage | 2 | 14.64 | 5 | 5 | 16.10 |
| Remove shoring from car: Includes breaking out and removing heavy, nailed-in shoring and bulkheads from car. Begins when the workers start travel to secure tools (approximately 50 feet). Ends when the tools have been returned to storage. Does not include time to remove the blocking, or bulkhead materials from the platform | 2 | 13.35 | 5 | 5 | 14.68 |
| Set up gravity roller conveyor: Includes positioning and blocking up a single 10-foot section of gravity roller conveyor with one end inside the car door and the other extending onto the platform. Begins when the workers start travel to get the conveyor and supports (approximately 50 feet) from storage. Ends when the conveyor is in position | 2 | 1.46 | 5 | 5 | 1.61 |
| Remove gravity roller conveyor: Includes removing a 10-foot section of gravity roller conveyor from the car. Begins with the travel of the workers to remove the conveyor (approximately 10 feet). Ends when the conveyor and supports have been placed in storage on the platform (approximately 50 feet) | 2 | .79 | 5 | 5 | .87 |
| Place bridge plate in car door with an industrial forklift truck: Includes picking up bridge plate from storage position on the platform and placing it in the car door. Begins with travel of the forklift truck, average 100 feet, to pick up bridge plate. Ends when forklift truck backs out empty after bridge plate is in position in car door | 1 | 1.35 | 5 | 5 | 1.49 |
| Remove bridge plate with industrial forklift truck: Elements required to remove bridge plate from car door and place it in storage on the platform. Begins with travel of forklift truck, average 100 feet, to the car. Ends when forklift truck backs out empty after bridge plate is in place in storage on platform (approximately 50 feet) | 1 | 1.10 | 5 | 5 | 1.21 |
| Place semilive skid and jack in car: Elements required to remove empty semilive skid and jack from storage on platform and transport it to car. Begins with travel of the workers to storage position on platform, approximately 50 feet, to secure the equipment. Ends when skid is in place inside car door | 1 | 1.25 | 5 | 5 | 1.37 |

TABLE 51.--Average labor requirements per occurrence for performing operations in connection with stamping lot numbers

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| Pick up stamp and pad: Elements required to pick up a rubber stamp and ink pad from a storage position within arm's reach, includes applying stamp to ink pad. Begins with travel of stamper's hand toward the stamp and pad. Ends when stamp is in position to stamp first container. Allow once for each unit load | *Number* 1 | *Man-minutes* 0.094 | *Percent* 5 | *Percent* 2 | *Man-minutes* 0.101 |
| Stamp lot number: Elements required to position stamp, impress stamp on outer surface of container, and remove stamp from surface of container. Allow once for each container in a unit load | 1 | .028 | 5 | 2 | .030 |
| Put stamp and pad aside: Elements required to replace stamp and pad in storage, within arm's reach, after completing stamping of containers in a unit load. Begins when stamp has been removed from last container stamped. Ends when stamp and pad have been returned to storage on the dock | 1 | .121 | 5 | 2 | .130 |
| Record count on piling card: Number of containers unloaded and containers stacked in storage rooms recorded on a tally form. The tally card is attached to a clip board at the car door or is retained by one member of the storage room crew. Begins with travel of worker, approximately 10 feet, to secure card. Ends when recording has been completed and card or clip board is replaced in storage | 1 | .162 | 5 | 2 | .173 |
| Staple piling card to container: Elements required, including 15 feet travel, to pick up a tally card and hand stapling machine, staple one card to one container on the first unit load, and return the stapling machine to storage on the dock. Do not use where it is necessary to staple or attach a separate lot tag to each container on the unit load. Begins with travel of handler to secure tag and stapling machine. Ends when stapling machine has been replaced in storage | 1 | .439 | 5 | 2 | .470 |
| Cut stencil--5 digits: Elements required to secure a stencil blank, cut a 5-digit stencil on a machine, and place the completed stencil on the machine table. Begins with travel of worker's hand to secure stencil blank within arm's reach. Ends when completed blank has been placed on machine table | 1 | .860 | 5 | 2 | .920 |
| Select stencil from group: Required when a number of lots are included in a single shipment and all of the lot stencils are cut at one time. Begins with reference by worker to shipment manifest. Ends when proper stencil has been removed from group and is held in worker's hand | 1 | .250 | 5 | 2 | .268 |
| Walk to stack: Time required to walk from stencil machine table to temporary storage position of lots. Begins with worker's travel, approximately 20 feet, to temporary storage position. Ends when worker has reached lots to be stamped | 1 | .110 | 5 | 2 | .118 |
| Stencil crates as directed by checker: Elements required to receive instructions from checker as to each individual crate to be marked, position stencil on crate to be marked, position stencil on container, brush ink over stencil, and remove stencil from crate. Begins with travel of worker toward selected container, approximately 20 feet. Ends when stencil has been removed from crate | 1 | .092 | 5 | 2 | .098 |
| Put stencil aside: Elements required to dispose of used stencil in a refuse container after crate has been marked. Begins with travel of worker toward refuse container, approximately 25 feet. Ends when used stencil has been dropped into refuse container | 1 | .145 | 5 | 2 | .155 |
| Record weights: Elements required to read gross and tare weights marked on container and call them out to checker. Begins with movement of worker, standing adjacent to unit load, to read weights from container. Ends when checker indicates he has recorded weights | 1 | .064 | 5 | 2 | .068 |
| Double-check lots: Time required, per container, to recheck count and weights of containers in an individual lot and to compare figures with receiving tally | 1 | .099 | 5 | 2 | .106 |
| Stamp lot number on various beef cuts: Quarters, rounds, chucks, loins, and ribs. Elements required to position stamp, impress stamp on outer surface of container, and remove stamp from surface of container. Allow once for each container in a unit load | 1 | .057 | 5 | 2 | .061 |

TABLE 52. --Average labor requirements per occurrence for performing operations in connection with checking weights on floor scale

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| Position pallet on scale with forklift truck: One checker and one forklift truck operator required. Elements required to position a loaded pallet, carried on an industrial forklift truck, and place the load on the platform of the scale. Begins with the start of a 90-degree turn of the forklift truck to place the load on the scale. Ends when the load has been placed on the scale with the forks of the lift truck still within the pallet........ | *Number* 2 | *Man-minutes* 0.180 | *Percent* 5 | *Percent* 5 | *Man-minutes* 0.198 |
| Back away empty with forklift truck: One checker and one forklift truck operator required. Time required to back the forklift truck so that the forks are clear of the pallet. Trucks back approximately 10 feet. Begins with backward travel. Ends when backward travel has been completed........ | 2 | .120 | 5 | 5 | .132 |
| Checker weighs load: One checker and one forklift truck operator required. Elements required for a checker to weigh the load on a floor scale. During this time, the forklift truck operator waits without dismounting from the truck. Begins with travel of checker's arm to balance beam. Ends when checker indicates he has recorded weight........ | 2 | .139 | 5 | 5 | .153 |
| Position forks to pick up load from scale: One checker and one forklift truck operator required. Time required for the forklift truck to travel approximately 10 feet forward in a straight line and position the lift forks within pallet on scale platform. Begins with forward travel. Ends when forks of truck are in position inside pallet and forward travel has been completed........ | 2 | .115 | 5 | 5 | .126 |
| Pick up load--back away loaded from scale: One checker and one forklift truck operator required. Time required for forklift truck to pick up load from scale platform and back away loaded from scale. A 90-degree turn is included in travel of approximately 15 feet. Begins with fork travel to lift load. Ends when loaded truck starts forward travel........ | 2 | .191 | 5 | 5 | .210 |
| Forklift truck operator weighs and records load: Includes time required, in addition to "checker roughs load," when forklift truck operator dismounts from truck, weighs load on floor scale, records weight, and remounts truck. Elements begin with end of backward travel of forklift truck ("back away empty forklift truck"). Ends when forklift truck operator has returned to his position on truck........ | 1 | .855 | 5 | 5 | .940 |
| Check count of containers on pallet: Extra time required, in addition to "forklift truck operator weighs and records load," to count containers on pallet which is being weighed........ | 1 | .193 | 5 | 5 | .212 |

TABLE 53. --Average labor requirements per occurrence for opening and closing highway trucks and trailers and related operations

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| Open highway trucks or trailers: Time required to open highway trucks or trailers. Begins with travel of workers, approximately 100 feet, toward highway truck. Open doors or gates, rig lights, secure and rig bridge plate, secure hand truck or semilive skid, and wait for sample inspection, if necessary. Ends when first container can be removed from loaded truck, or when first container can be stacked in empty truck.. | *Number* 2 | *Man-minutes* 10.09 | *Percent* 5 | *Percent* 5 | *Man-minutes* 11.10 |
| Close highway trucks or trailers: Time required to close highway trucks or trailers. Begins when last loaded or empty hand truck has been pushed clear of truck tail gate, or last loaded or empty pallet has been removed from platform area adjacent to highway truck tail gate. Remove light, remove bridge plate, close and latch door, and attach seals. Does not include removal of empty pallets from platform area. Ends when doors of truck have been closed........ | 2 | 2.53 | 5 | 5 | 2.78 |
| Check and record opening temperature: Time required to read and record the opening temperature of highway truck. The operation is performed in a number of ways:<br>a. By placing a thermometer in a number of places in the truck in succession, allowing it to remain in each position for a sufficient time to attain ambient temperature, removing the thermometer and recording the temperature.<br>b. By reading temperatures from thermometers permanently installed in truck.<br>c. By removing chart from recording thermometers placed in truck by shipper.<br>Begins with travel of worker toward truck, approximately 100 feet. Ends when temperature has been recorded on tally sheet........ | 1 | 5.33 | 5 | 5 | 5.86 |
| Wait for inspection: Members of unloading crew wait for inspection of carrier loads of meat. Includes any handling of containers required to secure samples........ | 2 | 6.41 | 5 | 5 | 7.05 |

TABLE 54. --Average labor requirements per occurrence for performing miscellaneous elements

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Tie top tier of cases with precut cord: Secure a precut length of cord. With loop tied in one end, place cord around top tier of cases, pass free end through loop, pull cord taut, and tie. Supply of cords is hung at doorway of rail cars or at dock end of trucks and trailers. Begins with travel of worker to secure cord, approximately 10 feet. Ends when cord has been placed around top tier of cases and fastened securely | 1 | 0.647 | 5 | 2 | 0.692 |
| Cut cord and tie top tier of cases: Cut length of cord from reel, pass cord around top tier of unit load of containers, draw cord tight, and tie ends. Reel is placed at doorway of railroad car or at tail gate of truck or trailer. Begins with travel of worker toward cord reel, approximately 10 feet. Ends when cord has been placed around top tier of cases and fastened securely | 1 | .526 | 5 | 2 | .563 |
| Secure wire tie machine, make one tie, wire tie, and push tie machine aside: Secure a reel of tie wire and a wire tie machine from storage position on platform, pass one end of wire around one tier of containers in a unit load, place end and bight of wire in tying machine, apply tension, tie and cut off wire, and replace wire reel and tying machine in storage. Begins with travel of worker to secure wire supply reel, approximately 20 feet. Ends when reel has been returned to storage on platform | 1 | .781 | 5 | 10 | .898 |
| Each additional wire tie with wire tie machine: Time required to make each additional wire tie, around tiers of containers in unit loads, with a wire tying machine. Time required is in addition to the time in "Secure wire tie machine, make one tie, wire tie, and push tie machine aside," for making first tie. Begins with movement of worker's hands to pass wire around tier of containers. Ends when wire has been cut off after making tie | 1 | .583 | 5 | 10 | .670 |
| Dismount and remount forklift truck when driver makes wire tie: Forklift truck operator dismounts from, and returns to, forklift truck seat when operator makes wire ties | 1 | .227 | 5 | 5 | .250 |
| Place cardboard binder between tiers of 30-pound cans: Secure sheet of cardboard and place it on top of tier of containers. Begins with travel of handler to secure binder, approximately 10 feet. Ends when binder is in place on tier of containers | 1 | .332 | 5 | 2 | .355 |
| Remove wire tie: Remove a wire tie from a tier of containers. Includes bending into a compact bundle and disposing of bundle into container close to operation. Begins with movement of worker's hand to secure shears to cut wire. Ends when wire has been dropped into refuse container | 1 | .330 | 5 | 10 | .380 |
| Hang fresh veal sides (160 pounds) in sharp freezer: | | | | | |
| Cut and tie cords: Cut heavy cord into lengths of approximately 24 inches and tie ends to form loop. The cord, from a supply reel, is wound around a wood form in a continuous strand to form 25 loops. The loops are cut along one side of the form which separates the strand into individual pieces. Ends of each piece are tied together to form a loop. A number of loops are then tied into a bundle and placed in a storage container. Begins with movement of worker's hand toward loose end of cord on supply reel. Ends when bundle of cords has been placed in storage container | 1 | .203 | 5 | 2 | .217 |
| Place cords in fresh veal sides: Includes passing one end of loop behind hind leg tendon of side of fresh veal, passing the other end of loop over tendon and through loop, and pulling cord tight around tendon. Twelve to fourteen sides are usually carried as a unit load. Begins with movement of worker's hand to secure pretied loop of cord. Ends when loop has been drawn taut around tendon | 1 | .246 | 5 | 2 | .263 |
| Hang veal sides on rack in sharp freezer: Includes removing one fresh veal side from a unit load and hanging it on rack in sharp freezer room. Operation is performed by looping cord attached to veal side over a nail or peg supported in one of horizontal members of freezer rack. Begins with travel of workers to pick up veal side, approximately 15 feet. Ends when workers release veal side on rack | 2 | .260 | 10 | 14 | .322 |
| Stack empty pallet (78 pounds each): Includes stacking empty pallets 4 or 5 high in sharp freezer room after loads have been removed from pallets. Unit loads observed for standard were 14 fresh veal sides each. Begins with travel of workers to pick up empty pallet, 5 to 20 feet. Ends when pallet has been released on stack (approximately 15 feet) | 2 | .322 | 10 | 10 | .386 |
| Remove veal sides from rack in sharp freezer and stack on pallets: | | | | | |
| Place empty pallet on floor: Includes removing empty pallets form 4- or 5-high stack in sharp freezer room and distributing them in a single row, approximately 2 feet apart. Observed operation is performed preparatory to loading frozen veal sides. Begins with start of travel of workers to pick up empty pallet, 5 to 20 feet. Ends when pallet has been released on floor (approximately 15 feet) | 2 | .377 | 10 | 10 | .452 |
| Remove veal sides from rack and stack on pallet: Includes relieving strain on supporting cord by raising side several inches, withdrawing cord loop from supporting nail or pin, transporting side to pallet, and stacking side on pallet. Transportation distance, 2 feet to 20 feet. Begins with travel of workers toward freezing rack. Ends when side has been released on pallet (approximately 15 feet) | 2 | .391 | 10 | 14 | .485 |
| Hang fresh beef hindquarters (200 pounds) in sharp freezer: | | | | | |
| Cut and tie cords: Same as cut and tie cords for fresh veal sides, except used with hindquarters | | | | | |
| Place cords in fresh beef hindquarters: Same as "Place cords in fresh veal sides," except used with beef hindquarters. 5 hindquarters are sometimes handled per pallet | 1 | .124 | 5 | 2 | .133 |
| Hang beef hindquarters on rack in sharp freezer: Same as "Hang veal sides on rack in sharp freezer," except used for beef hindquarters | 2 | .371 | 10 | 16 | .468 |
| Stack empty pallets (78 pounds each): Same as for veal sides, except for 5 beef hindquarters | 2 | .322 | 10 | 10 | .452 |
| Remove beef hindquarters from rack in sharp freezer: | | | | | |
| Place empty pallet on floor: Same as for veal sides | 2 | .377 | 10 | 10 | .452 |
| Remove beef hindquarters from rack and stack on pallet: Same as for veal sides, except used for beef hindquarters | 2 | .525 | 10 | 16 | .662 |
| Sort crates of turkeys by grade and weight: | | | | | |
| Lay out empty 40- by 48-inch pallets (78 pounds each) on platform: Includes removing empty pallets from 9-high supply stack and distributing them on platform preparatory to sorting operations. Average 6 to 8 pallets on platform. Five crates per tier on pallet. Begins with travel of worker to pick up empty pallet, 5 to 20 feet. Ends when pallet has been released on platform | 2 | .292 | 5 | 13 | .345 |
| Walk to bridge plate: 20 feet. Worker walks empty-handed from location on which last crate was stacked, average 20 feet, over bridge plate to railroad car door. Begins with travel of worker toward railroad car. Ends with passage of worker through railroad car door | 1 | .127 | 5 | 2 | .136 |

TABLE 54. --Average labor requirements per occurrence for performing miscellaneous elements--Continued

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| Pick up crate (55 pounds) in car and carry to bridge plate: Average time for all elements required to walk empty-handed from car door to work place inside car, pick up one 55-pound crate from stack in car, and carry crate to car door. Begins with entry of worker through car door. Ends with exit of worker through car door | *Number* 1 | *Man-minutes* 0.410 | *Percent* 5 | *Percent* 12 | *Man-minutes* 0.480 |
| Stack crate on proper pallet: Average time required to carry 55-pound crate from car door, over bridge plate, to proper pallet on platform, and handstack crate on pallet. Begins with exit of worker through car door. Ends with release of crate on the pallet | 1 | .111 | 5 | 12 | .130 |
| Handstack and strip crates for freezing: | | | | | |
| Secure supply of empty 40- by 48-inch pallets with industrial forklift truck: Includes picking up stack of 18 pallets with forklift truck from supply location, transport stack to car or truck unloading platform, and divide stack in stacks of 9 each on dock. Begins with start of travel of light fork-lift truck to pick up pallets, approximately 150 feet. Ends with completion of backward travel of forklift truck after positioning second group of 9 pallets | 1 | .090 | 5 | 5 | .099 |
| Place empty 40- by 48-inch pallets on platform: Time required to remove empty pallet from 9-high supply stack and place it on platform at car door or at truck tail gate. Begins with travel of worker to pick up pallet, approximately 20 feet. Ends when pallet has been released on platform | 1 | .292 | 5 | 13 | .345 |
| Place 40- by 48-inch separator pallet between tiers of crates: Includes securing empty pallet from supply stack and placing it on top of tier of containers. Begins with travel of worker to pick up pallet, approximately 20 feet. Ends when pallet is released on stack | 1 | .232 | 5 | 15 | .278 |
| Wait for industrial forklift truck to clear pallet from platform: Time for waiting for forklift truck to remove loaded pallet from platform at car door or at truck tail gate. Begins when last container of unit load has been stacked on pallet. Ends with end of backward travel of forklift truck as it removes pallet from platform or truck tail gate | 2 | .341 | 5 | 2 | .365 |
| Turn pallets of evaporated milk with special clamp (rotating attachment on industrial forklift truck): | | | | | |
| Forklift truck travel empty to stack and position special clamp to pick up loaded pallet: Includes forklift forward travel of approximately 40 feet, turning into adjacent row, and positioning forks and clamping attachment to pick up pallet loads. Loads are tiered from 1 to 3 pallets high. Begins with forward travel of forklift truck. Ends with completion of positioning of forks. (Observed operation covered unit loads of 50-pound cartons of evaporated milk) | 1 | .295 | 5 | 5 | .325 |
| Close special clamping attachment: Close clamping attachment preparatory to picking up load. Begins after completion of positioning element. Ends with completion of clamping operation | 1 | .194 | 5 | 5 | .213 |
| Pick up load--back away loaded from stack: Includes picking up clamped unit load and backing clear of stack while turning into adjacent row. Begins with backward travel of forklift truck. Ends with completion of backward travel | 1 | .180 | 5 | 5 | .198 |
| Travel loaded to restack, rotate special clamp while turning, and position and place: Includes rotating clamped unit load 180 degrees, traveling forward approximately 10 to 50 feet, positioning and placing unit load, and releasing clamp attachment. Travel and rotating load are performed simultaneously. Unit loads are tiered from 1 to 3 high. Begins with forward travel of forklift truck. Ends with completion of backward travel | 1 | .785 | 5 | 5 | .864 |
| Back away empty, forklift truck: Includes backing empty forklift truck from 20 feet to 70 feet while rotating forks and special clamping attachment 180 degrees. Begins with backward travel of forklift truck. Ends with completion of backward travel of empty forklift truck | 1 | .268 | 5 | 5 | .295 |

TABLE 55. --Average labor requirements per occurrence for performing miscellaneous operations in connection with unloading and loading railroad cars and highway trucks

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| Spot empty 4- or 6-wheel hand truck in railroad car: Includes pushing empty 4- or 6-wheel hand truck (250 pounds average) from railroad car door to work face inside car, positioning truck preparatory to loading, and turning truck crosswise in car, if necessary. Begins when truck passes through car door. Ends when hand truck is in place in car so that containers can be stacked on it | *Number* 1 | *Man-minutes* 0.173 | *Percent* 5 | *Percent* 2 | *Man-minutes* 0.185 |
| Push loaded 4- or 6-wheel hand truck through railroad car door: Includes pushing loaded 4- or 6-wheel hand truck (2,000 pounds average) from work face inside railroad car through car door. Begins with travel of workers toward loaded truck. Ends when loaded truck passes through car door | 2 | .183 | 5 | 11 | .212 |
| Spot loaded 4- or 6-wheel hand truck in railroad car: Includes pushing a loaded 4- or 6-wheel hand truck (2,000 pounds average) from rail car door to work face inside rail car, positioning truck at work face preparatory to unloading truck, and turning truck crosswise in car, if necessary. Begins when loaded truck passes through car door. Ends when truck is in place in car so that containers can be unloaded from truck | 2 | .192 | 5 | 11 | .223 |
| Push empty 4- or 6-wheel hand truck through railroad car door: Includes pushing a light 4- or 6-wheel hand truck (250 pound average) from work face inside railroad car through car door. Begins with worker's travel toward hand truck. Ends when empty truck passes through car door | 1 | .139 | 5 | 2 | .149 |
| Spot empty 4- or 6-wheel hand truck in highway truck or trailer: Same as "Spot empty 4- or 6-wheel hand truck in railroad car," except used for same operations in highway truck or trailer | 1 | .206 | 5 | 2 | .220 |
| Push loaded 4- or 6-wheel hand truck through highway truck or trailer tail gate: Same as "Push loaded 4- or 6-wheel hand truck through railroad car door," except used for same operations in highway truck or trailer | 2 | .261 | 5 | 11 | .303 |
| Spot loaded 4- or 6-wheel hand truck in highway truck or trailer: Same as "Spot loaded 4- or 6-wheel hand truck in railroad car," except used for same operations in highway truck or trailer | 2 | .215 | 5 | 11 | .249 |
| Push empty 4- or 6-wheel hand truck through highway truck or trailer tail gate: Same as "Push empty 4- or 6-wheel hand truck through railroad car door," except used for same operations in highway truck or trailer | 1 | .164 | 5 | 2 | .176 |

Table 56.--Average labor requirements per occurrence for performing operations in connection with handling barrels, hampers, baskets, and other noncubical rigid containers

| Operation description | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|
| | | | Personal | Fatigue | Cooler | Freezer |
| Containers weighing an average of 70 pounds: | | | | | | |
| Hand stack 1 tier high on pallet at car door: Includes rolling rigid noncubical container from position inside railroad car door and hand stacking on pallet. Pallet spotted on platform at car door or on bridge plate. Begins with travel of worker to pick up container. Ends when container has been released | *Number* 1 | *Man-minutes* 0.976 | *Percent* 5 | *Percent* 21 | *Man-minutes* 1.230 | -- |
| Containers weighing over 70 pounds: | | | | | | |
| Hand stack 1 tier high on pallet or hand truck at car door: Includes removing rigid noncubical container (70 pounds or over) from position in railroad car and hand stacking container on pallet or hand truck. The pallet or hand truck is spotted on platform at car door or on bridge plate. Begins with travel of workers to grasp container. Ends when container has been released on pallet or hand truck | 2 | .379 | 5 | 21 | .478 | -- |
| Hand stack 1 tier high on 4- or 6-wheel hand truck or pallet inside car: Same as above except pallet or hand truck is spotted inside railroad car or truck at work face | 2 | .262 | 5 | 21 | .330 | -- |
| Hand stack from pallet or 4- or 6-wheel hand truck: Includes picking up nonrigid cubical container, (70 pounds or over) from position on pallet or hand truck and hand stacking it in cooler (or freezer) storage room. The pallet or hand truck is spotted adjacent to work face. Containers are stacked up to 7 feet high. Begins with travel of workers to secure container. Ends when container has been released on stack | 2 | .262 | 5 | 21 | .330 | 0.343 |
| Hand stack on pallet or 4- or 6-wheel hand truck in cooler: Includes picking up rigid noncubical container (70 pounds or over) from position in cooler (or freezer) storage room stack and manually placing it on pallet or hand truck. The pallet or hand truck is spotted adjacent to stack. The storage room stacks are up to 7 feet high. Begins with travel of handlers to secure container. Ends when container has been released on pallet or hand truck | 2 | .262 | 5 | 21 | .330 | .343 |
| Hand stack 2 high in railroad cars or highway trucks from pallet or hand truck inside railroad car or highway truck: Includes picking up rigid noncubical container (70 pounds or over) from pallet or hand truck and manually positioning it in railroad car or highway truck or trailer. The loaded pallet or hand truck is spotted inside car or truck body adjacent to work face. Begins with travel of workers to secure container, and ends with container placed in position in car or truck | 2 | .170 | 5 | 21 | .214 | -- |
| 30-pound cans: | | | | | | |
| Hand stack containers on pallet or hand truck on platform: Begins with movement of worker to pick up container. Includes picking up 30-pound can from position inside railroad car door and hand stacking container on pallet or hand truck. The pallet or hand truck is spotted on platform at car door or on bridge plate. Ends when container has been released on pallet or hand truck | 1 | .184 | 5 | 9 | .210 | -- |
| Hand stack container on 4- or 6-wheel hand truck inside railroad car: Includes picking up 30-pound can from position inside railroad car and hand stacking it on pallet or hand truck. The pallet or hand truck is spotted inside car adjacent to work face. Used also for unloading highway trucks and trailers. Begins with movement of handler to pick up container. Ends when container has been released on pallet or hand truck | 1 | .122 | 5 | 9 | .139 | -- |
| Hand stack in cooler: Includes picking up 30-pound can from position on pallet or hand truck and hand stacking it in cooler (or freezer) stack. The pallet or hand truck is spotted adjacent to work face. Containers are stacked up to 7 feet high. Begins with movement of worker to pick up container. Ends when container has been released in stack | 1 | .100 | 5 | 9 | .114 | .119 |
| Hand stack on pallet or hand truck in cooler: Includes picking up 30-pound can from position in cooler (or freezer) storage room and hand stacking it on pallet or hand truck. The pallet or hand truck is spotted adjacent to stack. The storage room stacks are up to 7 feet high. Begins with movement of worker to pick up container. Ends when container has been released on pallet or hand truck | 1 | .100 | 5 | 9 | .114 | .119 |
| Hand stack in railroad car or highway truck from 4- or 6-wheel hand truck inside car or truck: Includes picking up 30-pound can from pallet or hand truck and manually positioning it in railroad car or highway truck or trailer. The loaded pallet or hand truck is spotted inside car or truck adjacent to work face. Begins with movement of worker to pick up container. Ends when container has been released on pallet or hand truck | 1 | .070 | 5 | 9 | .080 | -- |
| Hand stack in railroad car or highway truck from 4- or 6-wheel hand truck on dock: Same as above except pallet or hand truck is spotted on dock adjacent to car door or truck tail gate or on bridge plate | 1 | .103 | 5 | 9 | .117 | -- |
| Hand stack from platform over 7 feet high: Includes picking up 30-pound can from platform and hand stacking it in cooler (or freezer) room stack over 7 feet high. Simultaneously, another worker picks up can from hand truck or pallet, spotted adjacent to stack, and places it on platform. Begins with movement of worker to pick up container. Ends when container has been released in stack | 2 | .123 | 5 | 13 | .145 | .151 |
| Quart baskets: | | | | | | |
| Hand stack 11-quart baskets (16 pounds) up to 7 feet high: Includes hand stacking 11-quart baskets, for unloading cars, trucks, and trailers, hand stacking in storage rooms, breaking stack, and loading cars and trucks and trailers. Similar operations are described in detail for 30-pound cans. Begins with movement of worker to pick up container. Ends when container has been released in stack | 1 | .134 | 5 | 7 | .150 | .157 |
| Hand stack 11-quart baskets (16 pounds) over 7 feet high from platform: Same as for 32-pound cans, except used for 11-quart baskets. Includes picking up basket from platform and hand stacking it in cooler (or freezer) room stack over 7 feet high. Simultaneously, another worker picks up basket from hand truck or pallet, spotted adjacent to stack, and places it on platform. Begins with movement of worker to pick up container. Ends when container has been released in stack | 2 | .112 | 5 | 13 | .132 | .138 |
| Hand stack flat-bottom bushel baskets (42 pounds): Same as for 32-pound cans except used for flat-bottom bushel baskets. Includes picking up basket from pallet or hand truck and manually positioning it in railroad car or in highway truck. The loaded pallet or hand truck is spotted inside railroad car or highway truck adjacent to work face. Begins with movement of worker to pick up container. Ends when container has been released on pallet or hand truck | 1 | .121 | 5 | 10 | .139 | .145 |
| Pear boxes: | | | | | | |
| Hand stack 50-pound pear boxes up to 7 feet: Same as for 32-pound cans except used for 50-pound pear boxes. Includes picking up pear box from pallet or hand truck and manually positioning it in railroad car or highway truck. The loaded pallet or hand truck is spotted inside railroad car or highway truck adjacent to work face. Begins with movement of worker to pick up container. Ends when container has been released on pallet or hand truck | 1 | .200 | 5 | 11 | .232 | -- |

TABLE 57.--Average labor requirements for handstacking cartons, crates, or boxes of various weights onto or off a pallet or hand truck

| Operation description | Weight of container | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | *Pounds* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Unload railroad cars or highway trucks, handstack cartons on hand truck or pallet: Includes picking up carton, crate, or box from position inside railroad car or highway truck and handstacking it on pallet or hand truck. The pallet or hand truck is spotted inside car or truck adjacent to work face. Begins with movement of worker to pick up container. Ends when container has been released on pallet or hand truck.............. | 5 | 1 | 0.116 | 5 | 6 | 0.129 | -- |
| | 10 | 1 | .121 | 5 | 6 | .134 | -- |
| | 15 | 1 | .124 | 5 | 7 | .139 | -- |
| | 20 | 1 | .129 | 5 | 7 | .144 | -- |
| | 25 | 1 | .134 | 5 | 8 | .151 | -- |
| | 30 | 1 | .139 | 5 | 9 | .158 | -- |
| | 35 | 1 | .143 | 5 | 9 | .163 | -- |
| | 40 | 1 | .148 | 5 | 10 | .170 | -- |
| | 45 | 1 | .151 | 5 | 10 | .174 | -- |
| | 50 | 1 | .156 | 5 | 11 | .181 | -- |
| | 55 | 1 | .161 | 5 | 12 | .188 | -- |
| | 60 | 1 | .165 | 5 | 12 | .193 | -- |
| | 65 | 1 | .171 | 5 | 13 | .202 | -- |
| | 70 | 1 | .175 | 5 | 13 | .206 | -- |
| | 75 | 1 | .181 | 5 | 14 | .215 | -- |
| | 80 | 1 | .184 | 5 | 14 | .219 | -- |
| | 85 | 1 | .189 | 5 | 15 | .227 | -- |
| Unload railroad cars or highway trucks, handstack cartons on hand truck or pallet, handstack in cooler or freezer or break cooler or freezer stack: Average time for all elements required to pick up carton, crate, or box and handstack container on pallet or hand truck. The pallet or hand truck is spotted inside car or trailer body at work face. Used also for handstacking containers in storage rooms and breaking storage room stacks of cartons, crates, or boxes. Begins with movement of handler to pick up container. Ends with release of container in stack. Stacking height up to 7 feet.................. | 70 | 2 | .111 | 5 | 9 | .126 | .132 |
| | 75 | 2 | .115 | 5 | 10 | .132 | .138 |
| | 80 | 2 | .119 | 5 | 10 | .137 | .143 |
| | 85 | 2 | .123 | 5 | 10 | .141 | .148 |
| | 90 | 2 | .127 | 5 | 11 | .147 | .154 |
| | 95 | 2 | .130 | 5 | 11 | .151 | .157 |
| | 100 | 2 | .134 | 5 | 11 | .155 | .162 |
| | 105 | 2 | .137 | 5 | 11 | .159 | .166 |
| | 110 | 2 | .142 | 5 | 12 | .166 | .173 |
| | 115 | 2 | .146 | 5 | 12 | .171 | .178 |
| | 120 | 2 | .150 | 5 | 12 | .175 | .183 |
| | 125 | 2 | .155 | 5 | 12 | .181 | .189 |
| | 130 | 2 | .158 | 5 | 13 | .187 | .194 |
| | 135 | 2 | .162 | 5 | 13 | .191 | .199 |
| | 140 | 2 | .166 | 5 | 13 | .196 | .204 |
| | 145 | 2 | .171 | 5 | 14 | .203 | .212 |
| | 150 | 2 | .175 | 5 | 14 | .208 | .217 |
| | 155 | 2 | .178 | 5 | 14 | .212 | .221 |
| | 160 | 2 | .182 | 5 | 14 | .216 | .226 |
| | 165 | 2 | .187 | 5 | 14 | .222 | .232 |
| | 170 | 2 | .190 | 5 | 15 | .228 | .238 |
| | 175 | 2 | .195 | 5 | 15 | .234 | .244 |
| | 180 | 2 | .199 | 5 | 16 | .241 | .251 |
| | 185 | 2 | .204 | 5 | 16 | .247 | .257 |
| | 190 | 2 | .207 | 5 | 16 | .251 | .261 |
| | 195 | 2 | .211 | 5 | 16 | .255 | .266 |
| | 200 | 2 | .216 | 5 | 17 | .264 | .274 |
| | 205 | 2 | .220 | 5 | 17 | .268 | .279 |
| | 210 | 2 | .225 | 5 | 17 | .274 | .286 |
| | 215 | 2 | .229 | 5 | 18 | .282 | .293 |
| | 220 | 2 | .233 | 5 | 18 | .286 | .298 |
| | 225 | 2 | .237 | 5 | 18 | .292 | .303 |
| | 250 | 2 | .256 | 5 | 18 | .315 | .328 |
| Unload railroad cars or highway trucks, handstack cartons on hand truck or pallet: Includes picking up carton, crate, or box from position inside railroad car or highway truck and handstacking container on pallet or hand truck. The pallet or hand truck is spotted on platform at car or truck door or on bridge plate. Begins with movement of worker to pick up container. Ends when container has been released on pallet or hand truck........................................................................... | 5 | 1 | .158 | 5 | 6 | .175 | -- |
| | 10 | 1 | .167 | 5 | 6 | .185 | -- |
| | 15 | 1 | .177 | 5 | 7 | .198 | -- |
| | 20 | 1 | .188 | 5 | 7 | .211 | -- |
| | 25 | 1 | .199 | 5 | 8 | .225 | -- |
| | 30 | 1 | .210 | 5 | 9 | .239 | -- |
| | 35 | 1 | .219 | 5 | 9 | .250 | -- |
| | 40 | 1 | .230 | 5 | 10 | .265 | -- |
| | 45 | 1 | .240 | 5 | 10 | .276 | -- |
| | 50 | 1 | .252 | 5 | 11 | .292 | -- |
| | 55 | 1 | .263 | 5 | 12 | .308 | -- |
| | 60 | 1 | .274 | 5 | 12 | .320 | -- |
| | 65 | 1 | .285 | 5 | 13 | .336 | -- |
| | 70 | 1 | .294 | 5 | 13 | .347 | -- |
| | 75 | 1 | .306 | 5 | 14 | .364 | -- |
| | 80 | 1 | .316 | 5 | 14 | .376 | -- |
| | 85 | 1 | .330 | 5 | 15 | .396 | -- |
| Unload railroad cars or highway trucks, handstack cartons on hand truck or pallet: Begins with movement of workers to pick up container. Includes picking up carton, crate, or box from position in railroad car or highway truck and handstacking container on pallet or hand truck. The pallet or hand truck is spotted on platform at car or truck door or on bridge plate. Used also for loading cartons, crates, or boxes into rail cars or trailers when pallets or hand trucks are spotted on dock at car door or on bridge plate. Ends when container has been released on hand truck or pallet............................... | 70 | 2 | .160 | 5 | 9 | .182 | -- |
| | 75 | 2 | .166 | 5 | 10 | .191 | -- |
| | 80 | 2 | .173 | 5 | 10 | .199 | -- |
| | 85 | 2 | .177 | 5 | 10 | .204 | -- |
| | 90 | 2 | .184 | 5 | 11 | .214 | -- |
| | 95 | 2 | .189 | 5 | 11 | .219 | -- |
| | 100 | 2 | .193 | 5 | 11 | .224 | -- |

TABLE 57.--Average labor requirements for handstacking cartons, crates, or boxes of various weights onto or off a pallet or hand truck--Continued

| Operation description | Weight of container | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | Pounds | Number | Man-minutes | Percent | Percent | Man-minutes | |
| Continued from previous page. | 105 | 2 | 0.199 | 5 | 11 | 0.231 | -- |
| | 110 | 2 | .206 | 5 | 12 | .241 | -- |
| | 115 | 2 | .212 | 5 | 12 | .248 | -- |
| | 120 | 2 | .217 | 5 | 12 | .254 | -- |
| | 125 | 2 | .224 | 5 | 12 | .262 | -- |
| | 130 | 2 | .230 | 5 | 13 | .271 | -- |
| | 135 | 2 | .234 | 5 | .13 | .276 | -- |
| | 140 | 2 | .241 | 5 | .13 | .284 | -- |
| | 145 | 2 | .246 | 5 | .14 | .293 | -- |
| | 150 | 2 | .254 | 5 | .14 | .302 | -- |
| | 155 | 2 | .259 | 5 | .14 | .308 | -- |
| | 160 | 2 | .264 | 5 | .14 | .314 | -- |
| | 165 | 2 | .271 | 5 | .14 | .322 | -- |
| | 170 | 2 | .276 | 5 | .15 | .331 | -- |
| | 175 | 2 | .283 | 5 | .15 | .340 | -- |
| | 180 | 2 | .289 | 5 | .16 | .350 | -- |
| | 185 | 2 | .296 | 5 | .16 | .358 | -- |
| | 190 | 2 | .300 | 5 | .16 | .363 | -- |
| | 195 | 2 | .306 | 5 | .16 | .370 | -- |
| | 200 | 2 | .314 | 5 | .17 | .383 | -- |
| | 205 | 2 | .319 | 5 | .17 | .389 | -- |
| | 210 | 2 | .325 | 5 | .17 | .397 | -- |
| | 215 | 2 | .332 | 5 | .18 | .408 | -- |
| | 220 | 2 | .337 | 5 | .18 | .415 | -- |
| | 225 | 2 | .344 | 5 | .18 | .423 | -- |
| | 250 | 2 | .372 | 5 | .18 | .457 | -- |
| Break cooler or freezer stack, handstack on hand truck or pallet: Begins with movement of worker to pick up container. Includes picking up container from position on pallet or hand truck and stacking in cooler (or freezer) stack. The pallet or hand truck is spotted adjacent to work face. Used also for breaking cooler or freezer stacks to hand stack on pallet or hand truck spotted adjacent to stack. Ends when container has been released........ | 5 | 1 | .105 | 5 | 6 | .116 | 0.122 |
| | 10 | 1 | .105 | 5 | 6 | .117 | .122 |
| | 15 | 1 | .108 | 5 | 7 | .121 | .126 |
| | 20 | 1 | .109 | 5 | 7 | .122 | .128 |
| | 25 | 1 | .112 | 5 | 8 | .126 | .132 |
| | 30 | 1 | .113 | 5 | 9 | .129 | .134 |
| | 35 | 1 | .115 | 5 | 9 | .131 | .137 |
| | 40 | 1 | .117 | 5 | 10 | .135 | .140 |
| | 45 | 1 | .119 | 5 | 10 | .137 | .143 |
| | 50 | 1 | .122 | 5 | 11 | .141 | .148 |
| | 55 | 1 | .123 | 5 | 12 | .144 | .150 |
| | 60 | 1 | .126 | 5 | 12 | .147 | .154 |
| | 65 | 1 | .127 | 5 | 13 | .150 | .156 |
| | 70 | 1 | .130 | 5 | 13 | .153 | .160 |
| | 75 | 1 | .133 | 5 | 14 | .158 | .165 |
| | 80 | 1 | .134 | 5 | 14 | .159 | .166 |
| | 85 | 1 | .137 | 5 | 15 | .164 | .171 |
| Load railroad cars or highway trucks, handstack from hand truck or pallet located inside car or truck: Includes picking up carton, crate, or box from pallet or hand truck and stacking it in railroad car or highway truck. The pallet or hand truck is spotted inside car or truck adjacent to work face. Begins with movement of handler to pick up container. Ends when container has been released in stack........ | 5 | 1 | .059 | 5 | 6 | .066 | -- |
| | 10 | 1 | .064 | 5 | 6 | .071 | -- |
| | 15 | 1 | .068 | 5 | 7 | .076 | -- |
| | 20 | 1 | .073 | 5 | 7 | .082 | -- |
| | 25 | 1 | .075 | 5 | 8 | .085 | -- |
| | 30 | 1 | .080 | 5 | 9 | .091 | -- |
| | 35 | 1 | .083 | 5 | 9 | .095 | -- |
| | 40 | 1 | .088 | 5 | 10 | .101 | -- |
| | 45 | 1 | .091 | 5 | 10 | .105 | -- |
| | 50 | 1 | .095 | 5 | 11 | .110 | -- |
| | 55 | 1 | .100 | 5 | 12 | .117 | -- |
| | 60 | 1 | .103 | 5 | 12 | .121 | -- |
| | 65 | 1 | .108 | 5 | 13 | .128 | -- |
| | 70 | 1 | .112 | 5 | 13 | .132 | -- |
| | 75 | 1 | .117 | 5 | 14 | .139 | -- |
| | 80 | 1 | .120 | 5 | 14 | .143 | -- |
| | 85 | 1 | .124 | 5 | 15 | .149 | -- |
| Load railroad cars or highway trucks, handstack from hand truck on pallet located inside car or truck: Includes picking up carton, crate, or box from position inside railroad car or highway truck and handstacking container on pallet or hand truck. The pallet or hand truck is spotted adjacent to work face. Begins with movement of workers to pick up container. Ends when container has been released........ | 70 | 2 | .073 | 5 | 9 | .083 | -- |
| | 75 | 2 | .075 | 5 | 10 | .086 | -- |
| | 80 | 2 | .077 | 5 | 10 | .089 | -- |
| | 85 | 2 | .080 | 5 | 10 | .092 | -- |
| | 90 | 2 | .083 | 5 | 11 | .096 | -- |
| | 95 | 2 | .085 | 5 | 11 | .099 | -- |
| | 100 | 2 | .088 | 5 | 11 | .102 | -- |
| | 105 | 2 | .090 | 5 | 11 | .104 | -- |
| | 110 | 2 | .092 | 5 | 12 | .108 | -- |
| | 115 | 2 | .096 | 5 | 12 | .112 | -- |
| | 120 | 2 | .097 | 5 | 12 | .114 | -- |
| | 125 | 2 | .100 | 5 | 12 | .117 | -- |
| | 130 | 2 | .103 | 5 | 13 | .121 | -- |
| | 135 | 2 | .105 | 5 | 13 | .124 | -- |
| | 140 | 2 | .108 | 5 | 13 | .128 | -- |
| | 145 | 2 | .111 | 5 | 14 | .132 | -- |
| | 150 | 2 | .113 | 5 | 14 | .135 | -- |
| | 155 | 2 | .116 | 5 | 14 | .138 | -- |
| | 160 | 2 | .118 | 5 | 14 | .140 | -- |
| | 165 | 2 | .121 | 5 | 14 | .144 | -- |
| | 170 | 2 | .124 | 5 | 15 | .149 | -- |

TABLE 57.--Average labor requirements for handstacking cartons, crates, or boxes of various weights onto or off a pallet or hand truck--Continued

| Operation description | Weight of container | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| Continued from previous page. | *Pounds* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| | 175 | 2 | 0.127 | 5 | 15 | 0.152 | -- |
| | 180 | 2 | .129 | 5 | 16 | .156 | -- |
| | 185 | 2 | .132 | 5 | 16 | .160 | -- |
| | 190 | 2 | .135 | 5 | 16 | .163 | -- |
| | 195 | 2 | .137 | 5 | 16 | .166 | -- |
| | 200 | 2 | .142 | 5 | 17 | .173 | -- |
| | 205 | 2 | .143 | 5 | 17 | .175 | -- |
| | 210 | 2 | .146 | 5 | 17 | .178 | -- |
| | 215 | 2 | .149 | 5 | 18 | .183 | -- |
| | 220 | 2 | .151 | 5 | 18 | .186 | -- |
| | 225 | 2 | .155 | 5 | 18 | .191 | -- |
| | 250 | 2 | .167 | 5 | 18 | .206 | -- |
| Load railroad cars or highway trucks, handstack from a hand truck or pallet located adjacent to car door or truck tail gate: Includes picking up carton, crate, or box from pallet or hand truck and handstacking it in railroad car or highway truck. The pallet or hand truck is spotted on dock adjacent to car door or trailer tail gate or on bridge plate. Begins with movement of worker to pick up container. Ends when container has been released.......... | 5 | 1 | .086 | 5 | 6 | .096 | -- |
| | 10 | 1 | .094 | 5 | 6 | .104 | -- |
| | 15 | 1 | .098 | 5 | 7 | .110 | -- |
| | 20 | 1 | .105 | 5 | 7 | .118 | -- |
| | 25 | 1 | .109 | 5 | 8 | .123 | -- |
| | 30 | 1 | .116 | 5 | 9 | .132 | -- |
| | 35 | 1 | .121 | 5 | 9 | .138 | -- |
| | 40 | 1 | .128 | 5 | 10 | .147 | -- |
| | 45 | 1 | .132 | 5 | 10 | .152 | -- |
| | 50 | 1 | .139 | 5 | 11 | .161 | -- |
| | 55 | 1 | .143 | 5 | 12 | .167 | -- |
| | 60 | 1 | .150 | 5 | 12 | .175 | -- |
| | 65 | 1 | .158 | 5 | 13 | .186 | -- |
| | 70 | 1 | .162 | 5 | 13 | .191 | -- |
| | 75 | 1 | .169 | 5 | 14 | .201 | -- |
| | 80 | 1 | .174 | 5 | 14 | .207 | -- |
| | 85 | 1 | .180 | 5 | 15 | .216 | -- |
| Handstack, from platform in cooler or freezer; break cooler or freezer stack from platform: Includes picking up carton, crate, or box from pallet or hand truck and hand stacking it in cooler (or freezer) storage room. The pallet or hand truck is spotted adjacent to work face. Containers are stacked above 7-foot stacks up to 10 feet high in storage rooms. Stacking is done from platform. One worker stacks from pallet or hand truck to platform. One worker stacks from platform to pile. Also used for breaking 10-foot stacks into 7-foot stacks. Begins with movement of handler to pick up container from platform. Ends when container has been released.......... | 5 | 2 | .106 | 5 | 10 | .122 | .127 |
| | 10 | 2 | .107 | 5 | 10 | .123 | .128 |
| | 15 | 2 | .109 | 5 | 11 | .127 | .132 |
| | 20 | 2 | .111 | 5 | 12 | .130 | .135 |
| | 25 | 2 | .114 | 5 | 12 | .133 | .139 |
| | 30 | 2 | .115 | 5 | 13 | .136 | .141 |
| | 35 | 2 | .118 | 5 | 14 | .140 | .146 |
| | 40 | 2 | .120 | 5 | 14 | .143 | .149 |
| | 45 | 2 | .122 | 5 | 15 | .146 | .153 |
| | 50 | 2 | .125 | 5 | 16 | .151 | .158 |
| | 55 | 2 | .126 | 5 | 16 | .153 | .159 |
| | 60 | 2 | .129 | 5 | 17 | .157 | .164 |
| | 65 | 2 | .131 | 5 | 18 | .161 | .168 |
| | 70 | 2 | .133 | 5 | 18 | .164 | .170 |
| Unload railroad cars and highway trucks using gravity roller conveyor for cartons, and handstack on pallet or hand truck: Covers unloading from railroad car doorways only. (As soon as sufficient space has been opened into car for entrance of hand truck, conveyor is taken out. The remainder of unloading is performed by use of hand trucks alone). Includes one worker picking up container from car and placing it on conveyor. Container travels to dock end of conveyor by gravity. Second worker removes container from conveyor and handstacks it in position on pallet or hand truck. Conveyor loading and unloading elements are considered to be performed simultaneously. Begins with movement of worker to pick up container. Ends when container has been released on conveyor.......... | 5 | 2 | .126 | 5 | 6 | .140 | -- |
| | 10 | 2 | .133 | 5 | 6 | .148 | -- |
| | 15 | 2 | .141 | 5 | 7 | .158 | -- |
| | 20 | 2 | .151 | 5 | 7 | .169 | -- |
| | 25 | 2 | .159 | 5 | 8 | .180 | -- |
| | 30 | 2 | .168 | 5 | 9 | .191 | -- |
| | 35 | 2 | .175 | 5 | 9 | .200 | -- |
| | 40 | 2 | .184 | 5 | 10 | .212 | -- |
| | 45 | 2 | .191 | 5 | 10 | .220 | -- |
| | 50 | 2 | .202 | 5 | 11 | .234 | -- |
| | 55 | 2 | .210 | 5 | 12 | .246 | -- |
| | 60 | 2 | .219 | 5 | 12 | .256 | -- |
| | 65 | 2 | .228 | 5 | 13 | .269 | -- |
| | 70 | 2 | .236 | 5 | 13 | .279 | -- |

TABLE 58.--Average labor requirements per occurrence for handstacking bags, bales, and sacks onto or off a pallet or hand truck

| Operation description | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time: Cooler | Productive time: Freezer |
|---|---|---|---|---|---|---|
| 50-pound bags and sacks: | | | | | | |
| Handstack 50-pound sacks, all operations: Covers any workers handstacking operation in stacks under 7 feet high. Begins when workers start to reach for container. Ends when container has been released on hand truck, pallet, or in stack | *Number* 1 | *Man-minutes* 0.109 | *Percent* 5 | *Percent* 11 | *Man-minutes* 0.126 | -- |
| 100-pound bags and sacks: | | | | | | |
| Handstack containers on four- or six-wheel hand truck or pallet on platform: Begins when workers start to reach for container. Ends when container is released on hand truck or pallet | 2 | .134 | 5 | 11 | .155 | -- |
| Handstack containers on four- or six-wheel hand truck or pallet in car door: Begins when workers start to reach for the container. Ends when container is released on hand truck or pallet | 2 | .194 | 5 | 11 | .225 | -- |
| Handstack containers on four- or six-wheel hand truck or pallet inside railroad car or highway truck: Begins when workers start to reach for the container. Ends when container is released on hand truck or pallet | 2 | .134 | 5 | 11 | .155 | -- |
| Handstack in cooler (or freezer): Begins when workers start to reach for container. Ends when container is released into stack. Covers stacking to 7 feet high | 2 | .134 | 5 | 11 | .155 | 0.162 |
| Handstack on pallet or four- or six-wheel hand truck in cooler (or freezer): Begins when workers start to reach for container on hand truck or pallet. Ends when container is released on hand truck or pallet | 2 | .134 | 5 | 11 | .155 | .162 |
| Handstack container from pallet or four- or six-wheel hand truck inside car: Begins when workers start to reach for container on hand truck or pallet. Ends when container is released on stack inside the car or truck | 2 | .088 | 5 | 11 | .102 | -- |
| Load cars and highway trucks, hand stack, pallet in car door or on trailer tail gate: Begins when workers start to reach for container on hand truck or pallet. Ends when container is released on stack inside the car or trailer | 2 | .088 | 5 | 11 | .102 | -- |
| Load cars and highway trucks, hand stack, pallet or four- or six-wheel hand truck on dock: Begins when workers start to reach for container on hand truck or pallet. Ends when container is released on stack inside the car or trailer | 2 | .088 | 5 | 11 | .102 | -- |
| Handstack 100-pound paper sacks from platform: Covers stacking over 7 feet high. Two workers remove sacks from hand truck or pallet spotted on floor and stack the containers on the platform. Two workers remove containers from platform and stack in pile. Begins when workers start to reach for containers on platform and stack in the pile. Begins when workers start to reach for containers on platform. Ends when containers are released in the stack | 4 | .131 | 5 | 16 | .159 | -- |
| 150-pound bales: | | | | | | |
| Handstack burlap and straw-wrapped bales, all operations, 150 pounds: Covers any handstacking operation in stacks under 7 feet high. Begins when workers start to reach for container. Ends when container has been released on hand truck, pallet, or in stack | 2 | .298 | 5 | 14 | .355 | -- |

TABLE 59.--Average labor requirements per occurrence for handstacking 3 animal carcasses onto or off a pallet or hand truck

| Operation description | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time: Cooler | Productive time: Freezer |
|---|---|---|---|---|---|---|
| Beef hindquarters, 200 pounds average: | | | | | | |
| Unload cars and highway trucks, handstack, 4- or 6-wheel hand truck or pallet on dock: Begins when workers start to reach for hindquarter. Ends when hindquarter is released on hand truck or pallet | *Number* 2 | *Man-minutes* 0.457 | *Percent* 5 | *Percent* 17 | *Man-minutes* 0.558 | -- |
| Unload cars and highway trucks, handstack, pallet in car door: Begins when workers start to reach for hindquarter. Ends when hindquarter is released on hand truck or pallet | 2 | .457 | 5 | 17 | .558 | -- |
| Unload cars and highway trucks, handstack, pallet or 4- or 6-wheel hand truck inside car or highway truck: Begins when workers start to reach for hindquarter. Ends when hindquarter is released on hand truck or pallet | 2 | .457 | 5 | 17 | .558 | -- |
| Handstack in cooler (or freezer): Begins when workers start to reach for hindquarter. Ends when hindquarter is released into stack (approximately 4 feet high) | 2 | .457 | 5 | 17 | .558 | 0.580 |
| Break cooler (or freezer) stack, handstack on pallet or 4- or 6-wheel hand truck: Begins when workers start to reach for hindquarter in stack. Ends when quarter is released on hand truck or pallet | 2 | .457 | 5 | 17 | .558 | .580 |
| Load cars and highway trucks, handstack, pallet or 4- or 6-wheel hand truck inside car: Begins when workers start to reach for hindquarter on hand truck or pallet. Ends when hindquarter is released on stack inside car or trailer | 2 | .457 | 5 | 17 | .558 | -- |
| Load cars and highway trucks, handstack, pallet in car door or on trailer tail gate: Begins when workers start to reach for hindquarter on hand truck or pallet. Ends when hindquarter is released on stack inside car or trailer | 2 | .457 | 5 | 17 | .558 | -- |
| Load cars and highway trucks, handstack, pallet or 4- or 6-wheel hand truck on dock: Begins when workers start to reach for hindquarter on hand truck or pallet. Ends when hindquarter is released on stack inside car or highway truck | 2 | .457 | 5 | 17 | .558 | -- |
| Horse hindquarters, 225 pounds average: | | | | | | |
| Remove fresh hinds from car. Hang on special racks: Starts when workers reach for hindquarter in car. Ends when hindquarter is released on special rack | 2 | .622 | 5 | 18 | .765 | -- |
| Handstack horse hinds, all operations: Begins when workers start to reach for hindquarter. Ends when hindquarter has been released on hand truck, pallet, or in stack (approximately 4 feet high) | 2 | .540 | 5 | 18 | .664 | .69[illegible] |
| Hams, 14 to 18 pounds: | | | | | | |
| Handstack hams, all operations: Begins when worker starts to reach for ham. Ends when ham has been released on hand truck, pallet, or in stack | 1 | .072 | 5 | 7 | .081 | .084 |
| Beef forequarters, 175 to 195 pounds: | | | | | | |
| Handstack, beef forequarters, all operations, 175-195 pounds: Begins when workers reach for forequarter. Ends when forequarter has been released on hand truck, pallet, or in stack (3 carcasses to pallet or truck, 4 feet high in stack) | 2 | .496 | 5 | 16 | .600 | .625 |
| Beef loins, 75 pounds: | | | | | | |
| Handstack beef loins, all operations: Covers any handstacking operation in stacks under 7 feet high. Begins when worker starts to reach for loin. Ends when loin has been released on hand truck, pallet, or stack | 1 | .212 | 5 | 14 | .252 | .263 |
| Beef ribs, 32 pounds: | | | | | | |
| Handstack beef ribs, all operations: Begins when worker starts to reach for ribs. Ends when ribs have been released on hand truck, pallet, or stack | 1 | .178 | 5 | 9 | .203 | .212 |
| Lamb carcasses, 35 pounds: | | | | | | |
| Handstack lamb carcasses, all operations: Begins when worker starts to reach for carcass. Ends when carcass has been released on hand truck, pallet, or stack | 1 | .174 | 5 | 9 | .198 | .207 |

TABLE 60. --Average labor requirements for handstacking on pallets, miscellaneous elements

| Operation description | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time |
|---|---|---|---|---|---|
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Place empty pallet on semilive skid, on dock at highway truck tail gate, railroad car door, or inside railroad car at door: Begins with travel of worker to pick up empty pallet, approximately 20 feet. Ends when pallet has been released on semilive skid on highway truck at truck tail gate or car door, or inside car at door | 1 | 0.297 | 5 | 13 | 0.350 |
| Wait while industrial forklift truck clears load from highway truck tail gate: Consists of elapsed time of unloading crew while waiting for forklift truck to remove loaded pallet from truck tail gate. Begins with unit load in position for removal at truck tail gate. Ends with end of backward travel of forklift truck as it removes pallet from truck tail gate | 2 | .341 | 5 | 2 | .365 |
| Wait while forklift truck removes pallet from car door: Begins when pallet load is in position for removal at car door. Ends with end of backward travel of forklift truck when removing load from car door | 2 | .569 | 5 | 10 | .654 |
| Remove empty pallet from car of highway truck, stack on dock: Begins with travel of worker to pick up empty pallet, approximately 20 feet. Ends when empty pallet has been released in supply stack on dock | 1 | .246 | 5 | 13 | .290 |
| Push empty pallet on semilive skid to work face inside highway truck body: Begins with travel of worker toward semilive skid. Ends when semilive skid, with pallet, is in position at work face inside truck body | 1 | .089 | 5 | 2 | .095 |
| Place jack under loaded semilive skid, push loaded semilive skid to truck tail gate, jack aside: Begins with travel of worker to secure jack, approximately 15 feet. Ends when jack has been removed and placed in temporary position alongside highway truck | 1 | .556 | 5 | 12 | .650 |
| Spot loaded semilive skid in car, jack aside: Begins with travel of worker toward loaded semilive skid; grasps jack en route. Ends when jack has been removed and placed in temporary position along inside of highway truck | 1 | .363 | 5 | 12 | .425 |
| Place separator pallets on stack in sharp freezer: Includes time required to pick up and empty pallet from supply stack and place it on top of tier of containers. Begins with travel of worker to pick up pallet, approximately 20 feet. Ends when pallet is released on tier | 1 | .240 | 10 | 15 | .300 |

TABLE 61. --Average labor requirements per occurrence for transporting loads on dead skids

| Operation description | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time |
|---|---|---|---|---|---|
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Wait while hand platform truck removes loaded dead skid from railroad car door: Includes time of worker waiting for platform truck to remove loaded dead skid from car door. Begins when last container has been placed on dead skid. Ends when platform truck has removed loaded skid, approximately 10 feet, from car door | 1 | 0.626 | 5 | 10 | 0.720 |
| Wait while hand platform truck removes loaded dead skid from inside railroad car at door: Includes time of worker waiting for platform truck to remove loaded skid from inside car at door. Ends when platform truck has removed loaded skid, approximately 10 feet, from car door | 1 | 1.087 | 5 | 10 | 1.250 |
| Place dead skid in railroad car door: Begins with start of workers toward stack of empty skids, approximately 20 feet. Ends when empty skid has been released in position in railroad car door | 2 | .308 | 5 | 10 | .354 |
| Place dead skid inside railroad car door: Begins with start of workers toward stack of empty skids, approximately 20 feet. Ends when empty skid has been released in position inside railroad car | 2 | .341 | 5 | 10 | .392 |

TABLE 62.--Average labor requirements per occurrence for handling beef or horse hindquarters and hams on special racks

| Operation description | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time |
|---|---|---|---|---|---|
| Handle beef or horse hinds in special racks, mounted on 4-wheel trucks: | | | | | |
| Secure special rack, empty, 20 feet to 30 feet, place rack on platform at railroad car door, 110 pounds: Begins with travel of workers toward empty rack. Ends when empty rack is released in position on dock at railroad car door | *Number* 2 | *Man-minutes* 0.655 | *Percent* 5 | *Percent* 10 | *Man-minutes* 0.753 |
| Wait while platform truck, walkie-type, clears loaded special rack from railroad car door: Includes time of workers waiting for forklift truck to clear loaded rack from railroad car door. Begins when last carcass has been released in position on rack. Ends when platform truck has cleared loaded rack from car door, approximately 10 feet | 2 | .410 | 5 | 10 | .472 |
| Move empty beef- or horse-hind rack through railroad car door after loading carcasses in railroad car, 110 pounds: Begins with travel of workers toward empty rack. Ends when empty rack has been released in temporary storage position on platform, approximately 40 feet | 2 | .476 | 5 | 10 | .547 |
| Handle hams in special ham racks, mounted on 4-wheel hand trucks: | | | | | |
| Spot loaded ham rack in car, 1,900 pounds average: Begins when loaded rack passes through car door. Ends when loaded rack is in position at work face inside car | 2 | .409 | 5 | 11 | .475 |

TABLE 63.--Average labor requirements per occurrence for transporting loads on four- or six-wheel hand trucks

| Operation description | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time |
|---|---|---|---|---|---|
| Open or close vestibule or freezer doors, shoe opening, spring latch, 50 pounds equivalent: Starts with travel of worker toward freezer or vestibule door, 5 to 10 feet. Ends when worker releases latch handle of open or closed door after pushing truck through | *Number* 1 | *Man-minutes* 0.109 | *Percent* 5 | *Percent* 10 | *Man-minutes* 0.134 |
| Walk to loaded 4- or 6-wheel hand truck in vestibule, push load to room door, 2,000 pounds average: Begins with travel of worker toward loaded truck, approximately 10 feet. Ends with end of travel of loaded truck, approximately 20 feet previous to opening vestibule doors | 2 | .293 | 5 | 11 | .364 |
| Spot loaded 4- or 6-wheel hand truck at stack, 2,000 pounds average: Includes average travel of 20 feet from aisle to work face in stack. Begins with travel of workers toward loaded truck, approximately 10 feet | 2 | .269 | 5 | 11 | .334 |
| Push empty 4- or 6-wheel hand truck clear at stack, 250 pounds average: Includes average travel of 20 feet from work face to aisle. Begins with travel of worker toward empty truck. Ends when empty truck has been released in aisle | 1 | .211 | 5 | 2 | .240 |
| Spot empty 4- or 6-wheel hand truck at stack, 250 pounds average: Includes average travel of 20 feet from aisle to work face in stack. Begins with travel of worker toward empty truck, approximately 10 feet. Ends when empty truck is in position for loading at work face | 1 | .261 | 5 | 2 | .296 |
| Push loaded 4- or 6-wheel hand truck clear of stack: Includes average travel of 20 feet from work face to aisle. Begins with travel of workers toward empty truck. Ends when empty truck has been released in aisle | 2 | .299 | 5 | 11 | .372 |
| Walk to empty 4- or 6-wheel hand truck in vestibule, push empty truck to room door, 250 pounds average: Begins with travel of worker toward empty truck, approximately 10 feet. Ends with end of travel of empty truck, approximately 20 feet, previous to opening vestibule doors | 1 | .257 | 5 | 2 | .293 |
| Place empty pallet on 4- or 6-wheel hand truck, 75 pounds: Includes time required to remove empty pallet from supply stack and place on 4- or 6-wheel hand truck. The hand truck is spotted adjacent to supply stack. Begins with movement of worker to pick up empty pallet. Ends when pallet is in position on platform of hand truck | 1 | .222 | 5 | 14 | .284 |
| Turn loaded 6-wheel hand truck 180 degrees to ease steering: Workers generally find that loaded 6-wheel hand trucks maneuver more easily if swivel wheels are to rear of truck in contact with dock. If they find that truck has forward wheel in contact with dock, they usually rotate load 180 degrees to secure easy maneuvering. Begins with travel of worker toward loaded truck, approximately 10 feet. Ends when truck has been rotated and worker is in position at rear of truck to push load | 1 | .259 | 5 | 11 | .321 |

TABLE 64. --Average labor requirements per occurrence for walking to empty or loaded hand truck

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Walking to empty or loaded hand truck: Begins with start of worker's travel toward empty or loaded truck. Ends when the worker is in position to push truck................ | 10 | 1 | 0.091 | 5 | 2 | 0.097 | 0.102 |
| | 20 | 1 | .127 | 5 | 2 | .136 | .142 |
| | 30 | 1 | .167 | 5 | 2 | .179 | .187 |
| | 40 | 1 | .206 | 5 | 2 | .220 | .231 |
| | 50 | 1 | .244 | 5 | 2 | .261 | .273 |
| | 60 | 1 | .281 | 5 | 2 | .301 | .315 |
| | 70 | 1 | .320 | 5 | 2 | .342 | .358 |
| | 80 | 1 | .359 | 5 | 2 | .384 | .402 |
| | 90 | 1 | .397 | 5 | 2 | .425 | .445 |
| | 100 | 1 | .435 | 5 | 2 | .465 | .487 |
| | 110 | 1 | .473 | 5 | 2 | .506 | .530 |
| | 120 | 1 | .512 | 5 | 2 | .548 | .573 |
| | 130 | 1 | .551 | 5 | 2 | .590 | .617 |
| | 140 | 1 | .590 | 5 | 2 | .631 | .661 |
| | 150 | 1 | .628 | 5 | 2 | .672 | .703 |
| | 160 | 1 | .665 | 5 | 2 | .712 | .745 |
| | 170 | 1 | .704 | 5 | 2 | .753 | .788 |
| | 180 | 1 | .743 | 5 | 2 | .795 | .832 |
| | 190 | 1 | .780 | 5 | 2 | .835 | .874 |
| | 200 | 1 | .819 | 5 | 2 | .876 | .917 |
| | 210 | 1 | .858 | 5 | 2 | .918 | .961 |
| | 220 | 1 | .897 | 5 | 2 | .960 | 1.004 |
| | 230 | 1 | .935 | 5 | 2 | 1.000 | 1.047 |
| | 240 | 1 | .972 | 5 | 2 | 1.040 | 1.089 |
| | 250 | 1 | 1.012 | 5 | 2 | 1.083 | 1.133 |
| | 260 | 1 | 1.049 | 5 | 2 | 1.122 | 1.175 |
| | 270 | 1 | 1.088 | 5 | 2 | 1.164 | 1.219 |
| | 280 | 1 | 1.126 | 5 | 2 | 1.205 | 1.261 |
| | 290 | 1 | 1.164 | 5 | 2 | 1.246 | 1.304 |
| | 300 | 1 | 1.204 | 5 | 2 | 1.288 | 1.348 |

TABLE 65. --Average labor requirements per occurrence for transporting an empty 4- or 6-wheel 250-pound hand truck

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Transporting empty hand truck: Begins with forward travel of empty truck. Ends with completion of travel.................................................................. | 10 | 1 | 0.124 | 5 | 2 | 0.133 | 0.139 |
| | 20 | 1 | .161 | 5 | 2 | .172 | .180 |
| | 30 | 1 | .197 | 5 | 2 | .211 | .221 |
| | 40 | 1 | .234 | 5 | 2 | .250 | .262 |
| | 50 | 1 | .269 | 5 | 2 | .288 | .301 |
| | 60 | 1 | .306 | 5 | 2 | .327 | .343 |
| | 70 | 1 | .342 | 5 | 2 | .366 | .383 |
| | 80 | 1 | .379 | 5 | 2 | .405 | .424 |
| | 90 | 1 | .414 | 5 | 2 | .443 | .464 |
| | 100 | 1 | .450 | 5 | 2 | .482 | .504 |
| | 110 | 1 | .488 | 5 | 2 | .522 | .547 |
| | 120 | 1 | .523 | 5 | 2 | .560 | .586 |
| | 130 | 1 | .559 | 5 | 2 | .598 | .626 |
| | 140 | 1 | .595 | 5 | 2 | .637 | .666 |
| | 150 | 1 | .632 | 5 | 2 | .676 | .708 |
| | 160 | 1 | .669 | 5 | 2 | .716 | .749 |
| | 170 | 1 | .706 | 5 | 2 | .755 | .791 |
| | 180 | 1 | .742 | 5 | 2 | .794 | .831 |
| | 190 | 1 | .778 | 5 | 2 | .832 | .871 |
| | 200 | 1 | .813 | 5 | 2 | .870 | .911 |
| | 210 | 1 | .850 | 5 | 2 | .910 | .952 |
| | 220 | 1 | .886 | 5 | 2 | .948 | .992 |
| | 230 | 1 | .921 | 5 | 2 | .986 | 1.032 |
| | 240 | 1 | .964 | 5 | 2 | 1.032 | 1.080 |
| | 250 | 1 | .995 | 5 | 2 | 1.065 | 1.114 |
| | 260 | 1 | 1.033 | 5 | 2 | 1.105 | 1.157 |
| | 270 | 1 | 1.067 | 5 | 2 | 1.142 | 1.195 |
| | 280 | 1 | 1.104 | 5 | 2 | 1.181 | 1.236 |
| | 290 | 1 | 1.140 | 5 | 2 | 1.220 | 1.277 |
| | 300 | 1 | 1.176 | 5 | 2 | 1.258 | 1.317 |

TABLE 66. --Average labor requirements per occurrence for transporting loaded 4- or 6-wheel hand trucks, average weight 2,000 pounds

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Transport loaded hand truck: Begins with forward travel of loaded truck. Ends with completion of travel.................................................................. | 10 | 1 | 0.144 | 5 | 11 | 0.167 | 0.174 |
| | 20 | 1 | .191 | 5 | 11 | .221 | .231 |
| | 30 | 1 | .234 | 5 | 11 | .272 | .283 |
| | 40 | 1 | .280 | 5 | 11 | .325 | .339 |
| | 50 | 1 | .326 | 5 | 11 | .378 | .394 |
| | 60 | 1 | .371 | 5 | 11 | .430 | .449 |
| | 70 | 1 | .416 | 5 | 11 | .483 | .503 |
| | 80 | 1 | .461 | 5 | 11 | .535 | .558 |
| | 90 | 1 | .507 | 5 | 11 | .588 | .613 |
| | 100 | 1 | .552 | 5 | 11 | .640 | .668 |
| | 110 | 1 | .597 | 5 | 11 | .692 | .722 |
| | 120 | 1 | .642 | 5 | 11 | .745 | .777 |
| | 130 | 1 | .686 | 5 | 11 | .796 | .830 |
| | 140 | 1 | .733 | 5 | 11 | .850 | .887 |
| | 150 | 1 | .776 | 5 | 11 | .900 | .939 |
| | 160 | 1 | .823 | 5 | 11 | .955 | .996 |
| | 170 | 1 | .868 | 5 | 11 | 1.007 | 1.050 |
| | 180 | 1 | .914 | 5 | 11 | 1.060 | 1.106 |
| | 190 | 1 | .958 | 5 | 11 | 1.111 | 1.159 |
| | 200 | 1 | 1.003 | 5 | 11 | 1.163 | 1.214 |
| | 210 | 1 | 1.048 | 5 | 11 | 1.216 | 1.268 |
| | 220 | 1 | 1.095 | 5 | 11 | 1.270 | 1.325 |
| | 230 | 1 | 1.138 | 5 | 11 | 1.320 | 1.377 |
| | 240 | 1 | 1.183 | 5 | 11 | 1.372 | 1.431 |
| | 250 | 1 | 1.228 | 5 | 11 | 1.425 | 1.486 |
| | 260 | 1 | 1.274 | 5 | 11 | 1.478 | 1.542 |
| | 270 | 1 | 1.319 | 5 | 11 | 1.530 | 1.596 |
| | 280 | 1 | 1.363 | 5 | 11 | 1.581 | 1.649 |
| | 290 | 1 | 1.409 | 5 | 11 | 1.634 | 1.705 |
| | 300 | 1 | 1.453 | 5 | 11 | 1.686 | 1.758 |

TABLE 67. --Average labor requirement per occurrence for transporting pallets with an industrial forklift truck

| Operation description | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|
| | | | Personal | Fatigue | Cooler | Freezer |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Secure supply of empty pallets and place on dock at railroad car door or at trailer tail gate: Elements required to pick up stack of 18 pallets with industrial forklift truck from supply location, transport stack to railroad car or trailer unloading dock. Divide stack into 2 stacks of 9 each on dock. Begins with travel of empty forklift truck to pick up pallets, approximately 150 feet. Ends with completion of backward travel of forklift truck after positioning second group of 9 pallets | 1 | 0.090 | 5 | 5 | 0.099 | -- |
| Place empty pallet on semilive skid, on dock at trailer tail gate or railroad car door, or inside car at door: Time required to remove empty pallet from 9-high supply stack and place it on dock at car door or at trailer tail gate, or inside car at door. Begins with worker's travel to pick up pallet, approximately 20 feet. Ends when pallet has been released in position | 1 | .297 | 5 | 13 | .350 | -- |
| Position forklift truck on bridge plate to pick up load: Begins when forklift truck is within 5 feet of dock and bridge plate. Time required to raise forks into position to handle pallet. Ends with end of forward travel of forklift truck | 1 | .207 | 5 | 5 | .228 | -- |
| Travel loaded, outer switch to inner switch and vice versa, hand-operated electric switches: Begins after forklift truck operator has released door-operating switch outside air lock. Ends when truck operator presses door switch inside air lock. Used for entering and for leaving air lock | 1 | .251 | 5 | 5 | .276 | 0.289 |
| Travel empty outer switch to inner switch or vice versa, hand-operated electric switches: Begins after forklift truck operator has released door-operating switch inside air lock. Ends when truck operator presses door switch outside air lock. Used for entering and leaving air lock | 1 | .251 | 5 | 5 | .276 | .289 |
| Position fork truck on bridge plate, position load in railroad car door: Begins when forklift truck is within 5 feet of dock end of bridge plate. Time required to release load on railroad car floor rack inside door. Ends with end of released motion of forks | 1 | .257 | 5 | 5 | .283 | -- |
| Position forks, land load on dock, no positioning: This operation used to land loaded pallets on dock in temporary storage where no close positioning is required. Begins when truck is within 5 feet of storage position. Ends with end of releasing motion of forks | 1 | .073 | 5 | 5 | .080 | .084 |
| Position forks to pick up load on dock, 1st tier: Begins when forklift truck is within 5 feet of pallet load to be picked up. Includes time to raise forks into position to enter pallet of load standing on trailer. Ends with forward movement of forklift truck | 1 | .063 | 5 | 5 | .069 | -- |
| Pick up, back away with load: Begins with lifting movement of forks. Time required to back approximately 20 feet and make a 90-degree turn simultaneously. Ends with end of backward movement of truck | 1 | .202 | 5 | 5 | .222 | -- |
| Position forks--land load on dock: This operation is used to land pallet loads on dock in positions having margins of approximately 4 inches on each side of load. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .118 | 5 | 5 | .130 | -- |
| 3,000--4,000-pound electric fork truck on or off elevator empty: Approximately 20 feet travel of forklift truck. Begins with forward motion of forklift truck. Ends with end of forward motion of forklift truck | 1 | .284 | 5 | 5 | .312 | -- |
| Pick up single loads from floor, land on 4- or 6-wheel hand trucks: This operation requires a worker to position empty hand trucks, in addition to forklift truck operator. Approximately 10-foot travel of forklift truck to pick up load and approximately 5-foot travel with load before landing load on hand truck. Begins with forward travel of forklift truck. Ends with end of released motion of forks when landing load on hand truck | 2 | .555 | 5 | 5 | .610 | .638 |
| Double-deck pallets with forklift trucks: Positioning of forklift truck to pick up load and place it on top of another load standing on dock. Begins with forward motion of forklift truck to pick up load, approximately 5 feet. Ends with end of released motion of forks | 1 | .678 | 5 | 5 | .746 | .780 |
| Position forklift truck to pick up load on dock, 2nd tier: Begins with forward motion of forklift truck to pick up loaded pallet from 2nd tier, approximately 5 feet. Includes time to raise forks into position to enter pallet. Ends with end of forward motion of forklift truck | 1 | .112 | 5 | 5 | .123 | .129 |
| Pick up load with forklift truck, no back-away required: This operation performed when pallet loads are standing in storage position singly where they can be transported without backing away from a stack. Begins when load has been lifted from dock and forklift truck is free to move away from pickup position | 1 | .073 | 5 | 5 | .080 | .084 |
| Return empty pallets to pallet stack from trailer or railroad car dock: This operation is performed to return empty pallets from temporary position on loading docks to pallet supply stacks. Includes time required to double-deck two 9-high stacks and to transport resulting 18-high stack to supply position, approximately 150 feet. Begins with forward travel of forklift truck to double-deck stack. Ends with end of backward travel of forklift truck after 18-high stack has been placed in storage position | 1 | .138 | 5 | 5 | .152 | -- |

TABLE 68. --Average labor requirements per occurrence for industrial forklift travel

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | Feet | Number | Man-minutes | Percent | Percent | Man-minutes | |
| Forklift empty: Begins with forward travel of fork truck and ends when fork truck is within 5 feet of pickup position........ | 10 | 1 | 0.098 | 5 | 5 | 0.108 | 0.113 |
| | 20 | 1 | .120 | 5 | 5 | .132 | .138 |
| | 30 | 1 | .143 | 5 | 5 | .157 | .164 |
| | 40 | 1 | .166 | 5 | 5 | .183 | .191 |
| | 50 | 1 | .189 | 5 | 5 | .208 | .217 |
| | 60 | 1 | .211 | 5 | 5 | .232 | .243 |
| | 70 | 1 | .234 | 5 | 5 | .257 | .269 |
| | 80 | 1 | .257 | 5 | 5 | .283 | .296 |
| | 90 | 1 | .279 | 5 | 5 | .307 | .321 |
| | 100 | 1 | .302 | 5 | 5 | .332 | .347 |
| | 110 | 1 | .325 | 5 | 5 | .357 | .374 |
| | 120 | 1 | .346 | 5 | 5 | .381 | .398 |
| | 130 | 1 | .370 | 5 | 5 | .407 | .426 |
| | 140 | 1 | .393 | 5 | 5 | .432 | .452 |
| | 150 | 1 | .415 | 5 | 5 | .457 | .477 |
| | 160 | 1 | .437 | 5 | 5 | .481 | .503 |
| | 170 | 1 | .461 | 5 | 5 | .507 | .530 |
| | 180 | 1 | .484 | 5 | 5 | .532 | .557 |
| | 190 | 1 | .505 | 5 | 5 | .556 | .581 |
| | 200 | 1 | .528 | 5 | 5 | .581 | .607 |
| | 210 | 1 | .552 | 5 | 5 | .607 | .635 |
| | 220 | 1 | .573 | 5 | 5 | .630 | .659 |
| | 230 | 1 | .596 | 5 | 5 | .656 | .685 |
| | 240 | 1 | .619 | 5 | 5 | .681 | .712 |
| | 250 | 1 | .643 | 5 | 5 | .707 | .739 |
| | 260 | 1 | .665 | 5 | 5 | .731 | .765 |
| | 270 | 1 | .687 | 5 | 5 | .756 | .790 |
| | 280 | 1 | .710 | 5 | 5 | .781 | .817 |
| | 290 | 1 | .732 | 5 | 5 | .805 | .842 |
| | 300 | 1 | .755 | 5 | 5 | .831 | .868 |
| Forklift loaded (2,000 pounds): Begins with forward travel of fork truck and ends when fork truck is within 5 feet of final position........ | 10 | 1 | .138 | 5 | 5 | .152 | .159 |
| | 20 | 1 | .164 | 5 | 5 | .180 | .189 |
| | 30 | 1 | .192 | 5 | 5 | .211 | .221 |
| | 40 | 1 | .218 | 5 | 5 | .240 | .251 |
| | 50 | 1 | .246 | 5 | 5 | .271 | .283 |
| | 60 | 1 | .273 | 5 | 5 | .300 | .314 |
| | 70 | 1 | .299 | 5 | 5 | .329 | .344 |
| | 80 | 1 | .326 | 5 | 5 | .359 | .375 |
| | 90 | 1 | .353 | 5 | 5 | .388 | .406 |
| | 100 | 1 | .378 | 5 | 5 | .416 | .435 |
| | 110 | 1 | .405 | 5 | 5 | .446 | .466 |
| | 120 | 1 | .433 | 5 | 5 | .476 | .498 |
| | 130 | 1 | .459 | 5 | 5 | .505 | .528 |
| | 140 | 1 | .486 | 5 | 5 | .535 | .559 |
| | 150 | 1 | .514 | 5 | 5 | .565 | .591 |
| | 160 | 1 | .541 | 5 | 5 | .595 | .622 |
| | 170 | 1 | .567 | 5 | 5 | .624 | .652 |
| | 180 | 1 | .594 | 5 | 5 | .653 | .683 |
| | 190 | 1 | .620 | 5 | 5 | .682 | .713 |
| | 200 | 1 | .647 | 5 | 5 | .712 | .744 |
| | 210 | 1 | .674 | 5 | 5 | .741 | .775 |
| | 220 | 1 | .701 | 5 | 5 | .771 | .806 |
| | 230 | 1 | .727 | 5 | 5 | .800 | .836 |
| | 240 | 1 | .754 | 5 | 5 | .829 | .867 |
| | 250 | 1 | .782 | 5 | 5 | .860 | .899 |
| | 260 | 1 | .808 | 5 | 5 | .889 | .929 |
| | 270 | 1 | .835 | 5 | 5 | .919 | .960 |
| | 280 | 1 | .862 | 5 | 5 | .948 | .991 |
| | 290 | 1 | .888 | 5 | 5 | .977 | 1.021 |
| | 300 | 1 | .915 | 5 | 5 | 1.007 | 1.052 |
| Forklift backs away empty: Begins with end of releasing motion of forks and ends with end of backward movement of fork truck........ | 10 | 1 | .120 | 5 | 5 | .132 | .138 |
| | 20 | 1 | .138 | 5 | 5 | .152 | .159 |
| | 30 | 1 | .157 | 5 | 5 | .173 | .181 |
| | 40 | 1 | .176 | 5 | 5 | .194 | .202 |
| | 50 | 1 | .195 | 5 | 5 | .215 | .224 |
| | 60 | 1 | .214 | 5 | 5 | .235 | .246 |
| | 70 | 1 | .233 | 5 | 5 | .256 | .268 |
| | 80 | 1 | .252 | 5 | 5 | .277 | .290 |
| | 90 | 1 | .270 | 5 | 5 | .297 | .311 |
| | 100 | 1 | .289 | 5 | 5 | .318 | .332 |

TABLE 69.--Average labor requirements per occurrence for performing handlift truck operations

| Operation description | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|
| | | | Personal | Fatigue | Cooler | Freezer |
| | Number | Man-minutes | Percent | Percent | Man-minutes | |
| Spot empty dead skid in railroad car with hand-lift truck: Begins when the dead skid on lift truck passes through car door. Ends when skid is in position for loading at work face inside car......... | 2 | 0.250 | 5 | 2 | 0.268 | -- |
| Position hand-lift truck under empty or loaded dead skid: Elements required to back lift truck under loaded skid. Begins with backward motion lift truck. Ends with end of backward motion of lift truck | 2 | .343 | 5 | 2 | .367 | 0.384 |
| Pick up load with mechanical single- or double-stroke hand-lift trucks, 2,000 pounds limit: Begins with movement of lift truck to raise load. Ends with completion of lifting operation. Requires 1 or 2 strokes of lift truck handle.......... | 2 | .118 | 5 | 10 | .136 | .142 |
| Pick up load with hydraulic multistroke hand-lift truck, 4,000 pounds limit: Begins with movement of lift truck handle to raise load. Ends with completion of lifting operation. Requires approximately 7 strokes of lift truck handle.......... | 1 | .417 | 5 | 10 | .480 | .500 |
| Pull loaded skid through car door with hand-lift truck: Begins with forward motion of loaded skid. Ends when loaded skid passes through car door.......... | 2 | .359 | 5 | 12 | .420 | -- |
| Release load carried on hand-lift truck: Begins with motion of lift-truck handle required to release hold latch. Ends when legs of skid are in position on floor and lift truck is free to move away from load.......... | 2 | .094 | 5 | 2 | .101 | .105 |

TABLE 70.--Average labor requirements per occurrence for transporting loaded dead skids with hand-lift trucks[1]

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | Cooler | Freezer |
| | Feet | Number | Man-minutes | Percent | Percent | Man-minutes | |
| Transporting loaded dead skids (over 2,000 pounds): Begins with forward motion of lift truck. Ends with end of the forward motion of lift truck.......... | 10 | 2 | 0.183 | 5 | 14 | 0.218 | 0.227 |
| | 20 | 2 | .241 | 5 | 14 | .287 | .299 |
| | 30 | 2 | .297 | 5 | 14 | .353 | .368 |
| | 40 | 2 | .355 | 5 | 14 | .422 | .440 |
| | 50 | 2 | .413 | 5 | 14 | .492 | .512 |
| | 60 | 2 | .471 | 5 | 14 | .560 | .584 |
| | 70 | 2 | .528 | 5 | 14 | .628 | .655 |
| | 80 | 2 | .585 | 5 | 14 | .696 | .725 |
| | 90 | 2 | .643 | 5 | 14 | .765 | .797 |
| | 100 | 2 | .699 | 5 | 14 | .832 | .867 |
| | 110 | 2 | .758 | 5 | 14 | .902 | .940 |
| | 120 | 2 | .815 | 5 | 14 | .970 | 1.011 |
| | 130 | 2 | .871 | 5 | 14 | 1.036 | 1.080 |
| | 140 | 2 | .926 | 5 | 14 | 1.102 | 1.148 |
| | 150 | 2 | .983 | 5 | 14 | 1.170 | 1.219 |
| | 160 | 2 | 1.044 | 5 | 14 | 1.242 | 1.295 |
| | 170 | 2 | 1.101 | 5 | 14 | 1.310 | 1.365 |
| | 180 | 2 | 1.157 | 5 | 14 | 1.377 | 1.435 |
| | 190 | 2 | 1.214 | 5 | 14 | 1.445 | 1.505 |
| | 200 | 2 | 1.272 | 5 | 14 | 1.514 | 1.577 |

[1] For empty trucks use Table 65; and for loads up to 2,000 pounds use Table 66.

Table 71.--Average labor requirements per occurrence for walkie-type industrial forklift truck miscellaneous elements

| Operation description | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|
| | | | Personal | Fatigue | Cooler | Freezer |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Position forks to pick up loaded or empty pallet: Begins with forward motion of lift truck. Ends with end of lifting motion of forks (approximately 10 feet) | 1 | 0.365 | 5 | 10 | 0.420 | 0.438 |
| Position forks, land load, 1st tier: Time required to position and load on dock. Begins when loaded truck is within 5 feet of landing position. Ends when forklift truck is free to move away from load | 1 | .362 | 5 | 10 | .416 | .434 |
| Position forks, land load, 2nd tier: Time required to raise load high enough to pass over 1st tier, position, and land load on top of 1st tier. Begins when loaded truck is within 5 feet of landing position. Ends when truck is free to move away from the stack | 1 | .646 | 5 | 10 | .743 | .775 |
| Empty walking-type platform or tow truck on or off elevator: Use for walkie-type industrial lift truck or platform truck and for walkie-type, electric tow truck. Includes travel distance of approximately 20 feet. Begins with forward motion of truck. Ends with end of forward motion of truck | 1 | .203 | 5 | 10 | .234 | -- |
| Move loaded pallet on or off elevator with walkie-type platform truck: Includes travel distance of approximately 20 feet. Begins with forward motion of loaded truck. Ends with end of forward motion of truck | 1 | .620 | 5 | 10 | .713 | -- |
| Spot loads in elevator vestibule with walkie-type, industrial forklift truck or with walkie-type platform truck: This operation is usually performed by backing loaded truck into position and releasing load. Includes travel distance of approximately 40 feet. Begins with backward travel of truck. Ends when truck is free to move forward away from load | 1 | .412 | 5 | 10 | .474 | -- |

Table 72.--Average labor requirements per occurrence for semilive skids and jacks miscellaneous elements

| Operation description | Workers required | Base time | Allowance factors | | Productive time | |
|---|---|---|---|---|---|---|
| | | | Personal | Fatigue | Cooler | Freezer |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| Pick up loaded semilive skid with jack: Time required to secure jack, place it under lifting pivot, and raise load. Begins with travel of handler to secure jack, approximately 5 feet. Ends when semilive skid has been raised from floor and is free to move | 1 | 0.269 | 5 | 10 | 0.309 | 0.323 |
| Spot loaded semilive skid, release jack: This operation is usually performed by backing loaded semilive skid into position and releasing jack. Begins when loaded skid is within 5 feet of landing position. Ends when jack has been removed from lifting pivot | 1 | .459 | 5 | 10 | .528 | .551 |
| Turn loaded semilive skid 180 degrees with jack: Begins with turning of skid. Ends with completion of 180-degree turning movement | 1 | .276 | 5 | 10 | .317 | .331 |

Table 73.--Average labor requirements per occurrence for walkie-type industrial tractors miscellaneous elements[1]

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Couple walkie-type industrial tractor to empty or loaded four-wheel hand truck: This operation is performed by backing truck so that towing channel is in position behind front sill of hand truck and raising channel so that one leg is behind and the other leg is in front of hand truck sill. Begins when tow truck is within 5 feet of hand truck. Ends when towing channel is raised into position around truck sill | 1 | 0.339 | 5 | 10 | 0.390 |
| Spot loaded four-wheel hand truck and uncouple tractor: This operation usually performed by backing load with tow truck and releasing towing channel. Includes travel distance of approximately 10 feet. Begins with backward travel of truck. Ends when towing channel has been dropped and tow truck is free to move away from the load | 1 | .365 | 5 | 10 | .420 |
| Turn tractor 180 degrees to couple to load: Begins with turning motion of truck. Ends with completion of 180-degree turn | 1 | .422 | 5 | 10 | .485 |
| Spot loaded four-wheel hand truck in elevator with industrial tractor: This operation is usually performed by backing loaded hand truck onto elevator by means of tow truck. Begins with backward travel, distance of approximately 20 feet. Ends when tow truck passes off the elevator platform | 1 | .526 | 5 | 10 | .605 |

[1] See table 74 for transportation distances.

TABLE 74. --Average labor requirements per occurrence for walkie-type industrial tractors travel empty [1]

| Operation description | Distance traveled | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time: Cooler | Productive time: Freezer |
|---|---|---|---|---|---|---|---|
| Walkie-type industrial tractor travel empty: Begins with forward travel of truck. Ends with ending of forward travel of truck, or when truck is within 5 feet of a pickup position, or within 5 feet of end of a stacking row in storage rooms | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| | 10 | 1 | 0.176 | 5 | 5 | 0.194 | 0.202 |
| | 20 | 1 | .221 | 5 | 5 | .243 | .254 |
| | 30 | 1 | .265 | 5 | 5 | .291 | .305 |
| | 40 | 1 | .310 | 5 | 5 | .341 | .357 |
| | 50 | 1 | .354 | 5 | 5 | .389 | .407 |
| | 60 | 1 | .397 | 5 | 5 | .437 | .457 |
| | 70 | 1 | .442 | 5 | 5 | .486 | .508 |
| | 80 | 1 | .486 | 5 | 5 | .535 | .559 |
| | 90 | 1 | .531 | 5 | 5 | .584 | .611 |
| | 100 | 1 | .575 | 5 | 5 | .632 | .661 |
| | 110 | 1 | .618 | 5 | 5 | .680 | .711 |
| | 120 | 1 | .699 | 5 | 5 | .736 | .804 |
| | 130 | 1 | .707 | 5 | 5 | .778 | .813 |
| | 140 | 1 | .752 | 5 | 5 | .827 | .865 |
| | 150 | 1 | .795 | 5 | 5 | .875 | .914 |
| | 160 | 1 | .839 | 5 | 5 | .923 | .965 |
| | 170 | 1 | .884 | 5 | 5 | .972 | 1.017 |
| | 180 | 1 | .928 | 5 | 5 | 1.021 | 1.067 |
| | 190 | 1 | .973 | 5 | 5 | 1.070 | 1.119 |
| | 200 | 1 | 1.017 | 5 | 5 | 1.119 | 1.170 |
| | 210 | 1 | 1.061 | 5 | 5 | 1.167 | 1.220 |
| | 220 | 1 | 1.105 | 5 | 5 | 1.216 | 1.271 |
| | 230 | 1 | 1.149 | 5 | 5 | 1.264 | 1.321 |
| | 240 | 1 | 1.195 | 5 | 5 | 1.314 | 1.374 |
| | 250 | 1 | 1.238 | 5 | 5 | 1.362 | 1.424 |
| | 260 | 1 | 1.282 | 5 | 5 | 1.410 | 1.474 |
| | 270 | 1 | 1.326 | 5 | 5 | 1.459 | 1.525 |
| | 280 | 1 | 1.370 | 5 | 5 | 1.507 | 1.576 |
| | 290 | 1 | 1.414 | 5 | 5 | 1.555 | 1.626 |
| | 300 | 1 | 1.458 | 5 | 5 | 1.604 | 1.677 |

[1] See table 73 for miscellaneous elements.

TABLE 75. --Average labor requirements per occurrence for towing loads with a walkie-type industrial tractor [1]

| Operation description | Distance traveled | Workers required | Base time | Allowance factors: Personal | Allowance factors: Fatigue | Productive time: Cooler | Productive time: Freezer |
|---|---|---|---|---|---|---|---|
| Walkie-type industrial tractor travel loaded: Begins with forward travel of truck. Ends with ending of forward travel of truck, or within 5 feet of landing position | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* | |
| | 10 | 1 | 0.226 | 5 | 5 | 0.249 | 0.260 |
| | 20 | 1 | .276 | 5 | 5 | .304 | .317 |
| | 30 | 1 | .322 | 5 | 5 | .354 | .370 |
| | 40 | 1 | .376 | 5 | 5 | .414 | .432 |
| | 50 | 1 | .425 | 5 | 5 | .468 | .489 |
| | 60 | 1 | .475 | 5 | 5 | .522 | .546 |
| | 70 | 1 | .525 | 5 | 5 | .577 | .604 |
| | 80 | 1 | .575 | 5 | 5 | .632 | .661 |
| | 90 | 1 | .624 | 5 | 5 | .686 | .718 |
| | 100 | 1 | .674 | 5 | 5 | .741 | .775 |
| | 110 | 1 | .723 | 5 | 5 | .795 | .831 |
| | 120 | 1 | .772 | 5 | 5 | .849 | .888 |
| | 130 | 1 | .823 | 5 | 5 | .905 | .946 |
| | 140 | 1 | .872 | 5 | 5 | .959 | 1.003 |
| | 150 | 1 | .922 | 5 | 5 | 1.014 | 1.060 |
| | 160 | 1 | .971 | 5 | 5 | 1.068 | 1.117 |
| | 170 | 1 | 1.020 | 5 | 5 | 1.122 | 1.173 |
| | 180 | 1 | 1.071 | 5 | 5 | 1.178 | 1.232 |
| | 190 | 1 | 1.120 | 5 | 5 | 1.232 | 1.288 |
| | 200 | 1 | 1.169 | 5 | 5 | 1.286 | 1.344 |
| | 210 | 1 | 1.219 | 5 | 5 | 1.341 | 1.402 |
| | 220 | 1 | 1.268 | 5 | 5 | 1.395 | 1.458 |
| | 230 | 1 | 1.319 | 5 | 5 | 1.451 | 1.517 |
| | 240 | 1 | 1.368 | 5 | 5 | 1.505 | 1.573 |
| | 250 | 1 | 1.417 | 5 | 5 | 1.559 | 1.630 |
| | 260 | 1 | 1.467 | 5 | 5 | 1.614 | 1.687 |
| | 270 | 1 | 1.516 | 5 | 5 | 1.668 | 1.743 |
| | 280 | 1 | 1.567 | 5 | 5 | 1.724 | 1.802 |
| | 290 | 1 | 1.616 | 5 | 5 | 1.778 | 1.858 |
| | 300 | 1 | 1.665 | 5 | 5 | 1.832 | 1.915 |

[1] See table 73 for miscellaneous elements.

**TABLE 76.--Average labor requirements per occurrence for towing with an industrial gas operated tractor**

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Tow loaded trailers in trackless train with gasoline tractor, 3 to 5 trailers for distances over 600 feet: Begins with forward motion of train. Ends with end of forward motion of train; per foot of travel........ | 1 | 0.0044 | 5 | 5 | 0.0048 |
| Tow 3 to 5 empty trailers in trackless train with gasoline tractors for distances over 600 feet: Begins with start of forward motion of train. Ends with end of forward motion of train; per foot of travel........... | 1 | .0025 | 5 | 5 | .0027 |
| Walk to empty truck, uncouple truck (2) hooks: Includes unhooking to separate hooks connecting tractor and train. Begins with travel of handler toward train, approximately 20 feet. Ends when second hook has been released........ | 1 | .134 | 5 | 5 | .147 |
| Walk to loaded truck, couple truck (2) hooks: Time required to push two separate hooks attached to truck into towing eyes on the tractor or other trucks. Begins with travel of handler to hook up tractor and train, walks approximately 20 feet. Ends when second hook has been engaged in tractor and tractor is free to tow load........ | 1 | .336 | 5 | 5 | .370 |
| Position tractor to hook up train, 2 to 5 trailers: This operation is usually performed by backing tractor from 5 feet to 10 feet so that it is in position to hook up train. Begins with backward motion of tractor and train. Ends when second hook has been engaged........ | 1 | .182 | 5 | 5 | .200 |
| Off tractor seat, hook up train to tractor, return: Includes walking to rear of tractor and engaging two separate hooks into towing eyes to hook up tractor and train. Begins with driver's motion to dismount from tractor. Ends when driver has returned to his seat on tractor........ | 1 | .222 | 5 | 5 | .244 |

**TABLE 77.--Average labor requirements per occurrence for rolling barrels and drums miscellaneous elements**

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Roll barrels or drums from inside car to car door: Travel distance average 10 feet. Begins with start of forward travel of barrel or drum. Ends when barrel or drum passes through car door........ | 1 | 0.235 | 5 | 10 | 0.270 |
| Roll barrels or drums on or off elevator: Includes travel distance of approximately 20 feet. Begins with forward motion of barrel or drum. Ends with end of travel of barrel or drum........ | 1 | .270 | 5 | 10 | .311 |
| Roll barrels into highway truck: Average travel distance 30 feet. Begins with forward travel of barrel or drum. Ends when barrel or drum passes through highway truck tail gate or door........ | 1 | .313 | 5 | 10 | .360 |
| Stand barrels on end in highway truck: Begins with travel of workers toward drum, approximately 5 feet. Ends when drum has been raised to upright position in highway truck........ | 1 | .198 | 5 | 10 | .228 |

TABLE 78.--Average labor requirements per occurrence for rolling barrels and drums

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | |
| | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Rolling barrels or drums: Begins with forward motion of barrel or drum. Ends with end of forward motion of barrel of drum | 10 | 1 | 0.286 | 5 | 10 | 0.329 |
| | 20 | 1 | .340 | 5 | 10 | .391 |
| | 30 | 1 | .394 | 5 | 10 | .453 |
| | 40 | 1 | .449 | 5 | 10 | .516 |
| | 50 | 1 | .503 | 5 | 10 | .579 |
| | 60 | 1 | .557 | 5 | 10 | .640 |
| | 70 | 1 | .610 | 5 | 10 | .702 |
| | 80 | 1 | .665 | 5 | 10 | .765 |
| | 90 | 1 | .718 | 5 | 10 | .826 |
| | 100 | 1 | .773 | 5 | 10 | .889 |
| | 110 | 1 | .828 | 5 | 10 | .952 |
| | 120 | 1 | .881 | 5 | 10 | 1.013 |
| | 130 | 1 | .936 | 5 | 10 | 1.076 |
| | 140 | 1 | .990 | 5 | 10 | 1.138 |
| | 150 | 1 | 1.044 | 5 | 10 | 1.201 |
| | 160 | 1 | 1.097 | 5 | 10 | 1.262 |
| | 170 | 1 | 1.152 | 5 | 10 | 1.325 |
| | 180 | 1 | 1.207 | 5 | 10 | 1.388 |
| | 190 | 1 | 1.260 | 5 | 10 | 1.449 |
| | 200 | 1 | 1.315 | 5 | 10 | 1.512 |
| | 210 | 1 | 1.369 | 5 | 10 | 1.574 |
| | 220 | 1 | 1.423 | 5 | 10 | 1.636 |
| | 230 | 1 | 1.477 | 5 | 10 | 1.698 |
| | 240 | 1 | 1.531 | 5 | 10 | 1.761 |
| | 250 | 1 | 1.586 | 5 | 10 | 1.824 |
| | 260 | 1 | 1.639 | 5 | 10 | 1.885 |
| | 270 | 1 | 1.701 | 5 | 10 | 1.956 |
| | 280 | 1 | 1.748 | 5 | 10 | 2.010 |
| | 290 | 1 | 1.801 | 5 | 10 | 2.071 |
| | 300 | 1 | 1.855 | 5 | 10 | 2.133 |

TABLE 79.--Average labor requirements per occurrence for elevator operation miscellaneous elements

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Close elevator doors: Begins with operator's arm reaching for door. Ends when operator releases grasp on door | 1 | 0.086 | 5 | 2 | 0.092 |
| Open elevator doors: Begins with operator's arm opening door. Ends when operator releases grasp on open door | 1 | .093 | 5 | 2 | .099 |
| Push loaded four- or six-wheel hand truck off elevator, return to elevator or walk to load and push loaded four- or six-wheel hand truck onto elevator: Use either for pushing loaded hand trucks off elevator and return to elevator car or to push loaded hand trucks onto elevator. Includes travel distance of approximately 20 feet each way. Begins with operator's travel toward loaded truck. Ends when operator reaches position for closing elevator door | 1 | .335 | 5 | 11 | .389 |
| Push empty four- or six-wheel hand truck off elevator, return to elevator or walk to empty hand truck and push truck onto elevator: Includes travel distance of approximately 20 feet each way. Ends when operator reaches position for closing elevator door | 1 | .203 | 5 | 2 | .217 |
| Spot empty four-wheel hand truck in elevator vestibule: Time required for elevator operator in addition to preceding operation time to push empty truck an additional 10 feet into vestibule and spot it between other empty or loaded trucks | 1 | .171 | 5 | 2 | .183 |
| Spot loaded four-wheel hand truck in elevator vestibule: Time required for elevator operator, in addition to time for pushing loaded hand truck off elevator, to push loaded truck an additional 10 feet and to spot loaded truck between other empty or loaded trucks | 1 | .228 | 5 | 11 | .264 |

TABLE 80. --Average labor requirements per occurrence for elevator travel

| Operation description | Distance traveled | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|---|
| | | | | Personal | Fatigue | |
| | *Feet* | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Elevator travel 100 feet per minute: Begins with vertical travel of elevator. Ends with end of vertical travel of elevator | 12 | 1 | 0.135 | 5 | 2 | 0.144 |
| | 24 | 1 | .270 | 5 | 2 | .289 |
| | 36 | 1 | .406 | 5 | 2 | .434 |
| | 48 | 1 | .540 | 5 | 2 | .578 |
| | 60 | 1 | .676 | 5 | 2 | .723 |
| | 72 | 1 | .811 | 5 | 2 | .868 |
| | 84 | 1 | .947 | 5 | 2 | 1.013 |
| | 96 | 1 | 1.082 | 5 | 2 | 1.158 |
| | 108 | 1 | 1.215 | 5 | 2 | 1.300 |
| | 120 | 1 | 1.355 | 5 | 2 | 1.450 |
| | 144 | 1 | 1.621 | 5 | 2 | 1.735 |
| Elevator travel 150 feet per minute: Begins with vertical travel of elevator. Ends with end of vertical travel of elevator | 12 | 1 | .090 | 5 | 2 | .096 |
| | 24 | 1 | .180 | 5 | 2 | .193 |
| | 36 | 1 | .270 | 5 | 2 | .289 |
| | 48 | 1 | .360 | 5 | 2 | .385 |
| | 60 | 1 | .450 | 5 | 2 | .482 |
| | 72 | 1 | .540 | 5 | 2 | .578 |
| | 84 | 1 | .631 | 5 | 2 | .675 |
| | 96 | 1 | .721 | 5 | 2 | .771 |
| | 108 | 1 | .810 | 5 | 2 | .867 |
| | 120 | 1 | .901 | 5 | 2 | .964 |
| | 144 | 1 | 1.087 | 5 | 2 | 1.163 |
| Elevator travel 200 feet per minute: Begins with vertical travel of elevator. Ends with end of vertical travel of elevator | 12 | 1 | .067 | 5 | 2 | .072 |
| | 24 | 1 | .136 | 5 | 2 | .145 |
| | 36 | 1 | .203 | 5 | 2 | .217 |
| | 48 | 1 | .270 | 5 | 2 | .289 |
| | 60 | 1 | .337 | 5 | 2 | .361 |
| | 72 | 1 | .406 | 5 | 2 | .434 |
| | 84 | 1 | .473 | 5 | 2 | .506 |
| | 96 | 1 | .540 | 5 | 2 | .578 |
| | 108 | 1 | .608 | 5 | 2 | .651 |
| | 120 | 1 | .676 | 5 | 2 | .723 |
| | 144 | 1 | .810 | 5 | 2 | .867 |

TABLE 81. --Average labor requirements per occurrence for preparing handstacking platform in cooler and for stacking empty pallets

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Prepare platform for handstacking over 7 feet high in cooler room: Includes all time required to place 3 or 4, 3-foot long strips of 1-inch by 6-inch lumber on top of containers in a 5-foot high pallet stack. These strips are used as a platform from which the handlers stack containers over 7 feet in height. Begins with travel of workers to pick up strips, approximately 10 feet. Ends when last strip has been placed on 5-foot stack containers | 2 | 1.795 | 5 | 5 | 1.975 |
| Stack empty pallets after unloading in cooler: This operation is performed to place empty pallets in stacks up to 9-high after containers have been removed from pallet. Begins with travel of workers to pick up pallet, approximately 5 feet. Ends when pallet is released on stack | 2 | .157 | 5 | 5 | .173 |

TABLE 82.--Average labor requirements per occurrence for stacking pallet loads in cooler with an industrial forklift truck

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Postition forks to pick up load: Time required for forklift truck to release forks into position to enter pallet. Use for either first-, second-, or third-tier pallets. Begins when forklift truck is within 5 feet of pickup position. Ends with end of forward motion of forklift truck | 1 | 0.207 | 5 | 5 | 0.228 |
| Pick up load, first tier, back away with load: Time required to back 20 feet and make a 90-degree turn simultaneously. Begins with lifting movement of forks to pick up a first-tier load and back away. Ends with end of backward movement of truck | 1 | .191 | 5 | 5 | .210 |
| Pick up load, second tier, back away with load: Time required to back 20 feet and make a 90-degree turn simultaneously. Begins with lifting movement of forks to pick up a second-tier load and back away. Ends with end of backward movement of truck | 1 | .304 | 5 | 5 | .334 |
| Position forks, land load, first tier: This operation is used to land loads between adjacent pallet stacks in first tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .214 | 5 | 5 | .235 |
| Position forks, land load, second tier: This operation is used to land loads between adjacent pallet stacks in second tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .382 | 5 | 5 | .420 |
| Position forks, land load, third tier: This operation is used to land loads between adjacent pallet stacks in third tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .450 | 5 | 5 | .495 |
| Position forks, land load, fourth tier: This operation is used to land loads between adjacent pallet stacks in fourth tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .516 | 5 | 5 | .568 |
| Position forks, land load, fifth tier: This operation is used to land loads between adjacent pallet stacks in fifth tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .584 | 5 | 5 | .642 |

TABLE 83.--Average labor requirements per occurrence for preparing platform for handstacking in freezer and for stacking empty pallets

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | *Number* | *Man-minutes* | *Percent* | *Percent* | *Man-minutes* |
| Prepare platform for handstacking over 7 feet high: Includes all time required to place 3 or 4, 3-foot long strips of 1-inch by 6-inch lumber on top of containers in a 5-foot high pallet stack. These strips are used as a platform from which workers stack containers over 7 feet in height. Begins with travel of workers to pick up strips, approximately 10 feet. Ends when last strip has been placed on 5-foot stack of containers | 2 | 1.830 | 5 | 10 | 2.105 |
| Stack empty pallets after unloading in freezer: This operation is performed to place empty pallets in stacks up to 9-high after containers have been removed from pallet. Begins with travel of workers to pick up pallet, approximately 5 feet. Ends when pallet is released on stack | 2 | .160 | 5 | 10 | .184 |

TABLE 84.--Average labor requirements per occurrence for stacking loaded pallets in freezer with an industrial forklift truck

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | Number | Man-minutes | Percent | Percent | Man-minutes |
| Position forklift truck to pickup load: Time required for forklift truck to release forks into position to enter pallet. Use for either first-, second-, or third-tier pallets. Begins when forklift truck is within 5 feet of pickup position. Ends with end of forward motion of forklift truck | 1 | 0.212 | 5 | 10 | 0.244 |
| Pickup load, first tier, back away with load: Time required to back 20 feet and make a 90-degree turn simultaneously. Begins with lifting movement of forks to pickup a first-tier load and back away. Ends with end of backward movement of truck | 1 | .195 | 5 | 10 | .224 |
| Pickup load, second tier, back away with load: Time required to back 20 feet and make a 90-degree turn simultaneously. Begins with lifting movement of forks to pickup a second-tier load and back away. Ends with end of backward movement of truck | 1 | .310 | 5 | 10 | .356 |
| Position forks, land load, first tier: This operation is used to land loads between adjacent pallet stacks in first tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .217 | 5 | 10 | .250 |
| Position forks, land load, second tier: This operation is used to land loads between adjacent pallet stacks in second tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .389 | 5 | 10 | .447 |
| Position forks, land load, third tier: This operation is used to land loads between adjacent pallet stacks in third tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .458 | 5 | 10 | .527 |
| Position forks, land load, fourth tier: This operation is used to land loads between adjacent pallet stacks in fourth tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .527 | 5 | 10 | .606 |
| Position forks, land load, fifth tier: This operation is used to land loads between adjacent pallet stacks in fifth tier in storage rooms. Begins when forklift truck is within 5 feet of final position. Ends with end of releasing motion of forks | 1 | .596 | 5 | 10 | .685 |
| Lay out pallets, beef forequarters, in sharp freezer in single tier for freezing: This operation is performed by an industrial forklift truck. Time required to remove loaded pallets containing fresh beef forequarters from 3-high stack and place loaded pallets in position for freezing on floor of the sharp freezer room. Begins with forward travel of forklift truck to pickup pallets, approximately 10 feet. Ends when loaded pallets have been landed on the freezer room floor and forklift truck is free to back away from load; per pallet | 1 | .336 | 10 | 10 | .403 |
| Pickup load, third tier, back away with load: Time required for forklift truck to release forks into position to enter pallet. Begins when forklift truck is within 5 feet of the pickup position. Ends with end of forward motion of forklift truck | 1 | .364 | 5 | 10 | .419 |
| Pickup load, fourth tier, back away with load: Time required to back 20 feet and make a 90-degree turn simultaneously. Begins with lifting movement of forks to pickup a fourth-tier load and back away. Ends with end of backward movement of truck | 1 | .419 | 5 | 10 | .482 |
| Pickup load, fifth tier, back away with load: Time required to back 20 feet and make a 90-degree turn simultaneously. Begins with lifting movement of forks to pickup a fifth-tier load and back away. Ends with end of backward movement of truck | 1 | .474 | 5 | 10 | .545 |

TABLE 85.--Average labor requirments per occurrence for use of semilive skids miscellaneous elements

| Operation description | Workers required | Base time | Allowance factors | | Productive time |
|---|---|---|---|---|---|
| | | | Personal | Fatigue | |
| | Number | Man-minutes | Percent | Percent | Man-minutes |
| Wait, forklift truck lands load on semilive skid inside highway truck body: Time of workers while waiting for forklift truck to land a loaded pallet on a semilive skid in highway truck tail gate. Begins when empty pallet from previous load has been stacked on dock. Ends when loaded pallet has been released on semilive skid | 2 | 0.316 | 5 | 2 | 0.338 |
| Pull loaded semilive skid to work face, remove jack: Average time to push loaded pallets on semilive skid from truck tail gate at work face inside highway truck and remove jack. Begins with travel of workers toward semilive skid, approximately 5 feet. Ends when jack is released in position along inside of highway truck | 2 | .322 | 5 | 12 | .377 |

## Research Methods and Techniques

This section explains in detail the successive steps that were taken to make the time studies, establish the element standards, and compile the man-hour and cost summaries used in this report.

### DEFINITIONS OF TERMS

The terms used in the discussions of research methods and techniques have been defined as follows:

Materials-Handling Job--This work in public refrigerated warehouses has been divided into three jobs. These are: (1) Unloading from railroad car or highway truck and placing into storage, (2) intraplant handling--the moving of commodities from one location to another in the storage rooms of the warehouse--and (3) moving out of storage and loading into railroad cars or highway trucks.

Operation.--One of the larger subdivisions of a job.

Element--One of the subdivisions of an operation.

Breakpoint--The end of one element and the beginning of the next in the sequence of an operation. It is also the end of one operation and the beginning of the next in sequence of a materials-handling job.

Constant element--An element that has the same time value every time it occurs.

Variable element--An element that has different time values under different conditions. The variable elements in this report are: (1) Transportation elements where the travel time required depends upon the distance traveled, and (2) the time required to stack containers of various weights, where the time required to stack a container depends upon its weight.

Occurrence--The number of times an element is repeated in performing an operation, or the number of times an operation is completed in performing a job.

Cycle--A cycle is a series of elements required to complete an operation.

Cyclical elements--Those elements which occur during each cycle of an operation.

Noncyclical elements--Those elements which do not occur regularly in each operation.

Unavoidable delays--The delays which occur during an operation but which cannot be controlled by the workers.

Allowable delay--Same as unavoidable delay.

Avoidable delays--Those delays for which the workers are responsible, or which can be controlled or eliminated by them.

Leveling factor--This is a factor used by the time study observer to record his judgment of the rate at which the workers are performing their tasks. It is expressed in percent of normal effort. The rating factor has the same meaning as the leveling factor.

Normal--The rate at which well-trained, suitable workers perform their tasks. Normal effort can be sustained throughout the work day or shift.

Normalizing--The process of adjusting the time recorded for performing an element to the normal time for the element, usually by multiplying the recorded time as shown in the time study by the leveling factor.

Comparison sheets--These are tables of normal times for the same element taken from a number of time studies. The tables are set up to make comparisons between studies.

Group tabulation sheets--These are tables showing total normal minutes, number of occurrences, etc., for similar elements taken from a number of time studies.

Weighting--Data are weighted in order to determine the formula for the best line for a series of points, so that if one value appears twice as many times as another it will also have twice as much influence in the formula.

## METHOD OF COMPILING DATA, INDIVIDUAL LOCATIONS

Recording the time studies--Decimal minute watches were used to record the studies. The watches were allowed to run continuously during the studies. Readings were made at the breakpoints between the successive elements of an operation. A line was drawn through the element time block of any reading which was to be eliminated because of talking, unnecessary motions, or delays, etc. If the delay causing the elimination of the element was of considerable length, an explanation was noted in the element description column of the study and a reference letter entered in the element time block.

Recording the time studies presented certain adverse conditions which could be only partially counteracted by the observers. Some of the difficulty was caused by the low temperatures in the freezer rooms. During the freezer studies, the observers were relatively inactive so far as physical movement was concerned. Some precautions could be taken against the cold by wearing felt-topped boots, freezer coats, ear muffs, gloves, etc. It was possible to spend approximately 1 hour in temperatures from zero degrees to minus 10 degrees Fahrenheit in comparative comfort before it was necessary to warm up in an elevator vestibule or elsewhere.

A number of tests were made to determine the effects of wide variation in temperature upon the stop watches. This was done by comparing the total elapsed time for a series of studies, as shown by the stop watch, with the elapsed time, as shown by an ordinary watch which was not taken into the freezer rooms. At the same time, the ordinary watch was corrected by comparison with an accurate chronometer. The stop watch error determined in this manner during 1,702 minutes of recording was plus 0.192 percent. This error is regarded as insignificant and has been disregarded in the calculations.

The following time study principles were adhered to throughout the studies: (1) Constant elements were recorded separately from variable elements, (2) avoidable and unavoidable delays were recorded separately, (3) any deviation from the observer's conception of normal effort was recorded during the studies. Leveling factors were not noted in the studies unless the worker's effort was considered to be greater or less than standard (deviations were leveled, or normalized, to standard effort when the studies were analyzed), (4) details of weight handled, size and type of equipment and containers, stacking heights, and general conditions surrounding the studies were recorded on the observation sheets, (5) paths traveled, distances, and number and degree of turns were recorded on small-scale sketches of the warehouse or on the observation sheets. To determine the time for the individual elemental operations, each continuous reading was subtracted from the succeeding reading. The element time was entered in red in the time blocks above the continuous reading. All of the individual readings for the study were then totaled and compared with the overall time of the study; in this way clerical errors were minimized.

Time study summaries--The summaries, which are worksheet recapitulations of the data from a number of sheets of the same series of observations, were prepared for most of the studies. It was possible to analyze the shorter studies without preparing a summary. Readings for similar items were grouped together on the summaries under the various element descriptions on the comparison sheets to which they were posted. The comparison sheet number and line number were entered on the time study sheets for reference.

The total elapsed time, determined from the summary sheet, was carried to each comparison sheet. The total elapsed time, including "out" time, shown on the summary sheet was compared with the total of the element times as shown by the time study, and in this way clerical errors were eliminated.

Leveling factors, when shown on the time study, were noted on the summary sheets and the readings were adjusted to normal time on the summaries. The normal time study minutes were entered in a column of the summaries.

Comparison Sheet--Cyclical Elements--A separate set of comparison sheets was used for each location. These sheets were designed to furnish a means of assembling and comparing time values for similar elements as determined from a number of time studies. Descriptions of the elements were listed in the order in which the work was performed to complete the various operations. These sheets include columns used to record tentative element standards for each location. The tentative standards were used to make comparasons of time values for similar items between locations. The comparison sheets also furnished an index of the time studies or time study summaries available for use in making up the group tabulation sheets.

Comparison Sheet--Noncyclical Elements--The descriptions of the various noncyclical elements occurring during the time studies were listed along the left-hand side of the comparison sheet. These data were used in the computation of the standard allowances for noncyclical elements and allowable delays required for the calculation of elemental standard time values.

Group tabulation sheet--A series of group tabulation sheets was compiled for each warehouse as a basis for the calculation of normal element times of constants, and of equations for analysis curves for variables on a weighted basis. Data for similar elements were transferred from the time study summaries to the group tabulation sheets.

In general, the number of men engaged, total normal minutes, and number of cycles completed were posted to the group tabulation sheets for constant elements. Number of men engaged, total normal minutes, number of occurrances, travel distances in feet, and average normal minutes each were also posted for transportation elements. In addition, stacking elements were posted in the same manner as transportation elements, except that the "weight handled" rather than "transportation distance" was used.

Establishing the normal time for constant elements--When all of the time study data were posted to the group tabulation sheets, the weighted normal times for the constant elements were determined for the location. This was done by dividing the total elapsed time for all of the readings for the element by the total number of cycles completed. This resulted in the weighted normal element time for the element at the specific location.

Analysis curve, variable elements--Charts were prepared for the variable elements for each warehouse. Distance traveled in feet (or weight of container in pounds) was used as the abscissa and the average normal element time was used as the ordinate on the charts. Calculations to determine the best line were not completed for the charts for each warehouse. Such curves as were drawn were laid in by inspection only and were used to facilitate comparisons between warehouses.

Analysis of noncyclical elements and allowable delays--Information taken from the comparison sheets, concerning the noncyclical elements, was listed separately for each

warehouse. If the comparison sheet showed that more than one man was required for the element, the elapsed time shown on the comparison sheet was multiplied by the number of men, and the product entered in the analysis sheet for noncyclical elements.

## Methods of Compiling Data, Combined Locations

After the normal time for the constant elements was determined and the variable elements plotted for all locations, comparisons of similar data were made between locations. It was apparent that for a large number of elements, the variation in values between warehouses was slight and that it would be possible to combine similar data and to compute standard time values which would apply to all locations.

Analysis of variable elements, group tabulation sheets--Combined group tabulation sheets for the variable elements were compiled for the combined locations utilizing all of the information from the group tabulation sheets for the separate locations.

Calculation of best line-- Work sheets were prepared to assemble the information required to determine the value of the constants in the equation for the best line, and to determine the coefficients of correlation. The values used take into consideration the weighting or number of occurrences of each of the average times in normal minutes.

Charts were then prepared on which the values of the variable elements were plotted for all the locations combined.

Calculations of coefficient of correlation--The coefficient of correlation is a measure of the degree of dispersion from the curve of the points used in its development. It is, therefore, a measure of how accurately any value selected from the curve will reflect the actual data used in its construction. If all of the points should fall on the curve, the coefficient of correlation would be 1.0. As the points become farther dispersed, the coefficient drops from 1.0 toward 0.

Similar calculations were made for all of the curves used to determine time values for variable elements. It had been anticipated that a factor combining both the weight and volume of the containers would yield better results than the use of weight alone for the abscissa of the chart. A test of this principle was made, but the curve using weight alone proved to have the higher coefficient of correlation. All of the values for handstacking used in the table of element standards and in the cost comparisons are based upon weight alone.

Analysis of constant elements--After all of the time study data for constant elements for all locations combined had been posted to the group tabulation sheets, the normal time for the constant elements was determined for the combined locations.

Establishing element standards--In order to establish element standards from the normal element time for either constant or variable elements, it was necessary to add suitable allowances to compensate for: (1) Occurrence of noncyclical elements and unavoidable delays, (2) personal needs, and (3) fatigue occurring during the various operations. These allowances were established in the following manner:

1. Analysis, noncyclical elements and delays, all locations--Figures for all locations combined were grouped for comparison. The types of operations included in the final table of allowances are: Open railroad cars, open trucks, stamp lot number, check weights, miscellaneous operations, handstack, break stack, load cars, stack in cooler, stack in freezer, transportation on hand trucks, transportation on hand lifttrucks, transportation with semilive skids, roll barrels, transportation on riding-type forklift trucks, transportation on walking-type forklift trucks, towing with walking-type tractors, towing with gasoline tractors, elevator operation, loading railroad cars, and loading motor trucks and trailers. After the data for all locations had been assembled, the percentage of noncyclical ele-

ment time included in the net minutes for each type of operation was computed. The net minutes and the noncyclical element minutes included in the net minutes were listed for each type of operation, and the actual percentage of noncyclical element time was computed, as described above. After the actual percentages of noncyclical element time had been computed, the entire list was reviewed and standard percentages assigned for each group.

Since computation of the noncyclical element standards introduces an additional factor in the usual allowances used to level or normalize base times, it was decided in the interest of practicality to eliminate this factor from the table of element standards. In other words, since it is presumed that warehouse operators will make use of the table of element standards in order to derive synthetic time standards, measures were taken to make these standards less complex and easy to use. Inasmuch as time is a valuable commodity, in revising these tables of element standards the noncyclical element was combined with the base time, since, in the final analysis, it enters into the computation of the productive time.

2. Personal Allowance--An allowance of 5 percent was made to cover personal needs for all operations except for work in freezers. An additional 5 percent personal allowance was included for all operations where it was necessary to enter the freezer rooms.

3. Fatigue Allowance Curve--It is extremely difficult to determine accurately the effects of fatigue upon operation time through any nonlaboratory technique now known. The curves that were used were based upon allowances which have proved to be satisfactory in other situations.

Compiling cost summaries--A separate cost summary was compiled for each of the container types and each method for which comparative costs were computed. The summaries include cost summary number, data compiled, type of container, method used, type of transportation and handling equipment used, and distances traveled. The horizontal and vertical travel distances were selected after a review of the plans of the selected warehouses. The total horizontal distances are the same for both single and multistory warehouses. The elevator selected was capable of handling 2 hand trucks per trip and traveled at 100 feet per minute.

The operations required to complete each of the three materials-handling jobs were listed. The elements required to complete the operations were listed under the operation descriptions. The "Operation Standard" and "Line Number" and "Elapsed Minutes Each" for each element were transferred from the table of element standards.

The "Occurrences per Unit Load" is the number of repetitions of each element required to complete the operation of which it is a part. The number of occurrences per unit load depends upon the method of performing the operation and the size of the unit load. "Elapsed Minutes Each" was multiplied by "Occurrences per Unit Load" to determine "Elapsed Time per Unit Load--Minutes." This in turn was divided by 60 to determine "Elapsed Time per Unit Load--Hours." "Elapsed Time per Unit Load--Hours" was multiplied by "Unit Loads per Carrier." "Elapsed Hours per Carrier" was multiplied by the number of men required and the rate per hour for the class of labor used to determine "Labor Cost per Carrier."

The total "Labor Cost per Carrier" was determined for each of the three materials-handling jobs by the addition of the operation costs. "Total Labor Cost per Ton" was obtained by dividing the total labor cost for each job by the number of tons in the carrier.

Equipment hours required were calculated by multiplying the "Elapsed Hours per Carrier" by the number of pieces of equipment in use during the various operations. The total number of hours required for each type of equipment was determined for each job. These totals were multiplied by the cost per hour for the types of equipment used to determine the equipment cost per carrier. These totals were divided by the tons per carrier to determine the equipment cost per ton. The total labor and equipment cost for each materials-handling job and for the combined total were summarized.

TABLE 86.--Estimated cost of ownership and operation of various types of materials-handling equipment used in selected public refrigerated warehouses

| Type of equipment | Amount of equipment | Initial cost[1] | Years depreciation[2] | Assumed use per year | Ownership cost per year | | | | Operation cost per year | | | Total ownership and operating cost | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Depreciation | Interest at 2 1/2 percent | Insurance and taxes, 4 percent | Total | Gas, oil, and electricity[3] | Maintenance[4] | Total | Per year | Per hour of use |
| | Units | Dollars | Number | Hours | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Industrial forklift truck (4,000-pound capacity, electric) | | | | | | | | | | | | | |
| Machine | 1 | 5,380.00 | 10 | -- | 538.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 17.1-kwh capacity | 1 | 1,653.30 | 6.3 | -- | 262.43 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 1,120.00 | 10 | -- | 112.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | | 8,153.30 | -- | 2,000 | 912.43 | 203.83 | 326.13 | 1,442.39 | [5] 68.40 | 122.30 | 190.70 | 1,633.09 | 0.816 |
| Industrial forklift truck (3,000-pound capacity, electric) | | | | | | | | | | | | | |
| Machine | 1 | 4,830.00 | 10 | -- | 483.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 14.5-kwh capacity | 1 | 1,502.41 | 6.3 | -- | 238.47 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 908.00 | 10 | -- | 90.80 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | | 7,240.41 | -- | 2,000 | 812.27 | 181.01 | 289.61 | 1,282.89 | 58.20 | 108.60 | 166.80 | 1,449.69 | .724 |
| Industrial forklift truck (2,000-pound capacity, electric) | | | | | | | | | | | | | |
| Machine | 1 | 3,910.00 | 10 | -- | 391.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 11.6-kwh capacity | 1 | 1,167.50 | 6.3 | -- | 185.32 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 908.00 | 10 | -- | 90.80 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | | 5,985.50 | -- | 2,000 | 667.12 | 149.63 | 239.42 | 1,056.17 | 46.40 | 89.78 | 136.18 | 1,192.35 | .596 |
| Industrial high-lift truck, walkie-type (2,000-pound capacity, electric) | | | | | | | | | | | | | |
| Machine | 1 | 2,480.00 | 10 | -- | 248.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 5.21-kwh capacity | 1 | 482.60 | 6.3 | -- | 76.60 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 424.00 | 10 | -- | 42.40 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 3,386.60 | -- | 2,000 | 367.00 | 84.67 | 135.48 | 587.15 | 20.84 | 50.80 | 71.64 | 658.79 | .328 |
| Industrial straddle forklift truck, walkie-type (3,000-pound capacity, electric) | | | | | | | | | | | | | |
| Machine | 1 | 2,480.00 | 10 | -- | 248.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 5.21-kwh capacity | 1 | 482.60 | 6.3 | -- | 76.60 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 424.00 | 10 | -- | 42.40 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 3,386.60 | -- | 2,000 | 367.00 | 84.67 | 135.48 | 587.15 | 20.84 | 50.80 | 71.64 | 658.79 | .328 |
| Industrial tractor, walkie-type (200- to 700-pound draw bar pull, electric) | | | | | | | | | | | | | |
| Machine | 1 | 808.00 | 10 | -- | 80.80 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 3.48-kwh capacity | 1 | 352.70 | 6.3 | -- | 55.98 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 334.00 | 10 | -- | 33.40 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | 1 | 1,494.70 | -- | 2,000 | 170.18 | 37.37 | 59.79 | 267.34 | 13.92 | 22.42 | 36.34 | 303.68 | .151 |
| Industrial straddle forklift truck (3,000-pound capacity, electric) | | | | | | | | | | | | | |
| Machine | 1 | 3,425.00 | 10 | -- | 342.50 | -- | -- | -- | -- | -- | -- | -- | -- |
| Battery, 5.046-kwh capacity | 1 | 453.90 | 6.3 | -- | 72.05 | -- | -- | -- | -- | -- | -- | -- | -- |
| Charger | 1 | 404.00 | 10 | -- | 40.40 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 4,282.90 | -- | 2,000 | 454.95 | 107.07 | 171.32 | 733.34 | 20.16 | 64.24 | 84.40 | 817.74 | .408 |
| Industrial tractor (2,000-pound draw bar pull, gasoline) Machine | 1 | 2,166.00 | 5 | 2,000 | 433.20 | 54.15 | 86.64 | 573.99 | 188.00 | 216.60 | 404.60 | 978.59 | .489 |
| 4-wheel hand truck (2,500-to 3,500- pound capacity, steel wheels, platform size 30- by 66-inch) Machine | 1 | 47.92 | 10 | [6] 2,000 | 4.79 | 1.20 | 1.42 | 7.91 | -- | 4.79 | 4.79 | 12.70 | .0063 |
| 6-wheel hand truck (2,000- to 3,000-pound capacity, steel wheels, platform size 30- by 66-inch) Machine | 1 | 55.50 | 10 | [6] 2,000 | 5.55 | 1.39 | 2.22 | 9.16 | -- | 5.55 | 5.55 | 14.71 | .0072 |
| Semilive skid (2,500-pound capacity, iron wheels, platform size 36- by 60-inch) | 1 | 37.68 | 10 | [6] 2,000 | 3.76 | .94 | 1.51 | 6.21 | -- | 3.76 | 3.76 | 9.97 | .0049 |
| Jack lift for semilive skid (3,000-pound capacity), iron wheels) | 1 | 47.12 | 10 | [6] 2,000 | 4.71 | 1.18 | 1.88 | 7.77 | -- | 4.71 | 4.71 | 12.48 | .0062 |
| Gravity roller conveyor (12 inches wide by 10 feet long with 2 adjustable supports) | 1 | 60.67 | 10 | [6] 2,000 | 6.07 | 1.52 | 2.43 | 10.02 | -- | 6.07 | 6.07 | 16.09 | .0080 |
| Pallet dolly (3,150-pound capacity, size 36- by 36-inch) | 1 | 77.70 | 10 | [6] 2,000 | 7.77 | 1.94 | 3.10 | 12.81 | -- | 7.77 | 7.77 | 20.58 | .0102 |
| Pallets (36- by 48-inch, 4-way) | 100 | 280.00 | 3 | 10 | 93.33 | 7.00 | 11.20 | 111.53 | -- | 28.00 | 28.00 | 139.53 | 13.95 |
| Pallets (40- by 40-inch, 2-way) | 100 | 273.00 | 3 | 10 | 91.00 | 6.82 | 10.92 | 108.74 | -- | 27.30 | 27.30 | 136.04 | 13.60 |
| Pallets (40- by 48-inch, 2-way) | 100 | 296.00 | 3 | 10 | 98.60 | 7.40 | 11.84 | 117.84 | -- | 29.60 | 29.60 | 147.44 | 14.74 |
| Pallets (40- by 48-inch, 4-way) | 100 | 322.00 | 3 | 10 | 107.33 | 8.05 | 12.88 | 128.26 | -- | 32.20 | 32.20 | 160.46 | 16.04 |
| Bridge plate (steel, 36 inches wide by 60 inches long) | 1 | 104.00 | 5 | 2,000 | 20.80 | 2.60 | 4.16 | 27.56 | -- | -- | -- | 27.56 | .0137 |

See footnotes at end of table

TABLE 86. --Estimated cost of ownership and operation of various types of materials-handling equipment used in selected public refrigerated warehouses--Continued

| Type of equipment | Amount of equipment | Initial cost[1] | Years depreciation[2] | Assumed use per year | Ownership cost per year | | | | Operation cost per year | | | Total ownership and operating cost | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Depreciation | Interest at 2 1/2 percent | Insurance and taxes, 4 percent | Total | Gas, oil, and electricity[3] | Maintenance[4] | Total | Per year | Per hour of use |
| Elevator (3-ton capacity, platform size 7 feet 6 inches by 8 feet, 9 floors) | *Units* | *Dollars* | *Number* | *Hours* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Elevator (2 floors) | 1 | 10,400.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 7 additional floors | -- | 7,000.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Manually operated doors | [8] 12 | 6,900.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 24,300.00 | 20 | 2,000 | 1,215.00 | 607.50 | 972.00 | 2,794.50 | 32.00 | 243.00 | 275.00 | 3,069.50 | 1.53 |
| Elevator (2 1/2-ton capacity, platform size 7 feet 6 inches by 12 feet, 7 floors) | | | | | | | | | | | | | |
| Elevator (2 floors) | 1 | 11,000.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 5 additional floors | -- | 5,000.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Manually operated doors | [9] 7 | 4,025.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 20,025.00 | 20 | 2,000 | 1,001.25 | 500.63 | 801.00 | 2,302.88 | 32.00 | 200.25 | 232.25 | 2,535.13 | 1.27 |
| Elevator (2 1/2-ton capacity, platform size 8 by 11 feet, 5 floors) | | | | | | | | | | | | | |
| Elevator (2 floors) | 1 | 9,700.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 3 additional floors | -- | 3,000.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Manually operated doors | [9] 5 | 2,875.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 15,575.00 | 20 | 2,000 | 778.75 | 389.38 | 623.00 | 1,791.13 | 32.00 | 155.75 | 187.75 | 1,978.88 | .99 |
| Elevator (1 1/2-ton capacity, platform size 8 feet by 8 feet, 5 floors) | | | | | | | | | | | | | |
| Elevator (2 floors) | 1 | 8,500.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 3 additional floors | -- | 3,000.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Manually operated doors | [9] 5 | 2,875.00 | | | | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | -- | 14,375.00 | 20 | 2,000 | 718.75 | 359.38 | 575.00 | 1,653.13 | 32.00 | 143.75 | 175.75 | 1,828.88 | .91 |

[1] Obtained from manufacturer of equipment:
- Industrial forklift trucks, electric, f.o.b. Philadelphia, Pa.
- Industrial high-lift truck, walkie-type, electric, f.o.b. Chicago, Ill.
- Industrial tractor, walkie-type, electric, f.o.b. Philadelphia, Pa.
- Industrial straddle forklift truck, electric, f.o.b. Philadelphia, Pa.
- Industrial tractor, gasoline, f.o.b. Jackson, Mich.
- Four- and six-wheel hand trucks, f.o.b. Faribault, Minn.
- Semilive skid and jack, f.o.b. Cleveland, Ohio
- Roller conveyor, f.o.b. York, Pa.
- Pallet dolly, f.o.b. Long Island City, N. Y.
- Pallets, f.o.b. Cleveland, Ohio; New York, N. Y; Washington, D. C.

[2] Basis for number of years depreciation - U.S. Internal Revenue Department's Bulletin "F"

[3] Average cost in industry: Gasoline $.23 gallon, oil $.40 quart, electricity $.01 kilowatt hour

[4] Maintenance costs computed at following percentages of initial cost:
- 1% - Elevators
- 1-1/2% - Electric trucks
- 10%-Gas tractors, 4- and 6-wheel hand trucks, semilive skid and jack, roller conveyor, pallet dolly, pallets

[5] Power costs for battery charging of electric-powered vehicles computed from manufacturers' specifications.
Example:
Battery capacity - 17.1 kwh. Discharge rate per hour - 10% of battery capacity.
17.1 kwh x .10 equals 1.71 kwh capacity per hour battery charging requirement.
1.71 x 2 (50% charging efficiency) equals 3.42 kwh charging requirement for each hour of vehicle use.
3.42 x $.01 (electricity cost per kwh) equals charging cost for each hour of vehicle use or $.0342.
$.0342 x 2,000 hours equals $68.40 per year, power cost.

[6] The 2,000 hours of assumed use per year is an estimate which serves as a base for conservative estimates of ownership and operating costs for this equipment.

[7] Elevator cost is the installed cost of elevator without doors, serving 2 floors. An additional amount is charged for each floor to be served over the 2 floors; also, an additional amount is charged for number of doors required. Door prices vary between different types of doors. Manually operated doors cost $575 each.

[8] First 3 floors, 2 doors each; top 6 floors, 1 door each

[9] One door per floor



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